(Constable)

THE

BOOK OF THE RIFLE

SERGT.-INSTR. WALLINGFORD, THE BEST SHOT IN THE BRITISH ARMY

THE

BOOK OF THE RIFLE

BY THE

HON. T. F. FREMANTLE, V.D.

MAJOR, 1ST BUCKS V.R.C.

WITH NUMEROUS ILLUSTRATIONS

LONGMANS, GREEN, AND CO.

39 PATERNOSTER ROW, LONDON

NEW YORK AND BOMBAY

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H.S.

To the Memory of

MY VERY DEAR FRIENDS

SIR HENRY ST. JOHN HALFORD

AND

MR. WILLIAM ELLIS METFORD

WHO FOR THIRTY YEARS STUDIED RIFLE PROBLEMS TOGETHER

I DEDICATE THIS BOOK

PREFACE

Many books have been written about arms and about rifles, yet so rapidly does invention move, that the subject is never exhausted. The events of the last two years have aroused a new interest in the rifle; soldiers, volunteers, civilians, all are alike keenly alive to its importance. At last we have begun to understand that the man, armed with a rifle, who is not expert in its use, is a mere military fraud, and that, if he is to acquire skill, the only prescription is—a delightful pastime.

I desire to acknowledge gratefully the ungrudging help of the many friends who have aided or advised me on points connected with this book. Were I to thank them separately, my preface would resemble a long bidding-prayer. I would also record my warm sense of much goodwill and pleasant companionship during more than twenty-one years of rifle work, helped especially by patient and ungrudging kindness from shooting men of an older generation.

There can be no finality in the evolution of firearms, at least until some quite new power of destruction shall make them obsolete. The present work, imperfect as it is, may serve to record the point which the rifle has attained at the opening of the twentieth century.

T. F. F.

Holton Park, Oxford:
November 1901.

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THE

BOOK OF THE RIFLE

CHAPTER I

Errata

page	19,	line	4,	*for*	Sir Isambard Brunel *read* Mr. Brunel
„	48	„	12	„	100 *read* 400.
„	264	„	29	„	two minutes *read* one minute
„	265	„	7	„	142 *read* 145
„	265	„	9	„	16 feet *read* 6 ft. 8 in.
„	265	„	10	„	30 feet *read* 12 ft. 8 in.
„	272	„	19	„	has *read* have

that the old means of propelling round or pointed missiles by the agency of human muscular force, first applied directly, in throwing, and then indirectly, as in the catapult and bow, has been superseded by the use of explosive compounds, chemically or mechanically mixed, and ignited in a cylinder, only one end of which is open, so that a missile may be carried out on the crest of the wave of explosion concentrated in one direction. Progress in such matters, as in all other departments of human invention, has become more and more rapid; one change has succeeded another, and become itself a step for greater and more rapid improvements.

There seems to be no record of the use of gunpowder as a means of projecting missiles until about six hundred years ago, and, considering the comparative feebleness of the first

THE
BOOK OF THE RIFLE

CHAPTER I

DEVELOPEMENT OF MISSILE WEAPONS—INVENTION OF RIFLE-GROOVING—EARLY USE OF RIFLES ON THE CONTINENT—PITCH OF SPIRAL—WHITWORTH'S CONCLUSIONS—METFORD'S INCREASING SPIRAL—MEANS OF ROTATING A BULLET OTHER THAN GROOVING

THE whole tactics of war and the whole of the sportsman's methods alike depend upon the developement of missile weapons, and upon the destructive power which can be concentrated in a form small enough to be easily conveyed to the place where it may be made effective. Hence the importance of firearms, which can be conveyed wherever a man can go, and which, whether great or small, are infinitely more powerful than the missile weapons which they superseded. It is only in the later days of the world's history that the old means of propelling round or pointed missiles by the agency of human muscular force, first applied directly, in throwing, and then indirectly, as in the catapult and bow, has been superseded by the use of explosive compounds, chemically or mechanically mixed, and ignited in a cylinder, only one end of which is open, so that a missile may be carried out on the crest of the wave of explosion concentrated in one direction. Progress in such matters, as in all other departments of human invention, has become more and more rapid; one change has succeeded another, and become itself a step for greater and more rapid improvements.

There seems to be no record of the use of gunpowder as a means of projecting missiles until about six hundred years ago, and, considering the comparative feebleness of the first explosive compounds, as well as the difficulty of producing and working metal capable of controlling even such power as they possessed, it is almost a matter of surprise that the first firearms should have come into use in competition with the older arms. Indeed, the struggle of the bow against its new rival, the gun, was prolonged for centuries. It found a convinced and able champion in Sir John Smythe, an old soldier of great experience, who in 1590 published 'Certain Discourses concerning the formes and effects of diuers sorts of weapons, and chiefly, of the Mosquet, the Caliuer, and the Long-bow; as also of the great sufficiencie, excellencie, and wonderful effects of archers.' This well-known writer attributes the comparative disfavour into which the long-bow had fallen much more to the want of systematic exercise with it than to the superior virtues of firearms. The advantage which he claimed for the bow was largely one of range. He speaks of the ill effect of 'volees' at more than forty paces at the furthest, but allows the effectiveness of fire from 'caliuers' and 'harquebuzes' at the very shortest distances. With these two weapons no rest was used; the 'mosquet,' being much larger and heavier, was fired from a rest, but had little advantage in range. Three hundred years ago firearms were quite ineffective in wet weather. Pikemen were an absolutely necessary accompaniment of 'mosquettiers' to protect them against cavalry. The rapidity of fire from bows was quite four times as great as that from firearms. The penetration of the bullet was so small that strong armour was not ineffective against it.

If confirmation be necessary the following passage from a book, 'Instructions for the Warres,' really written by de Fourquevaux, though commonly attributed to de Bellay, and translated from the French by Paul Ive in 1589, will give it:—

'The Harquebusse hath bin inuented within these fewe yeares, and is verie good, so that it be vsed by those that haue skill, but at this present euery man will be a Harquebusier: I knowe not whether it be to take the more wages, or to be the lighter laden, or to fight the further off, wherein there must be an order taken, to appoint fewer Harquebusiers, and those that are good, than many that are worth nothing:

for this negligence is cause that in a skirmish wherein tenne thousand Harquebussados are shot, there dieth not so mutch as one man, for the Harquebusiers content themselves with making of a noyse, and so shoote at all aduentures.'

The effectiveness of the musket was much increased by the invention of the flint-lock, which remained in use for nearly two hundred years, and still more, at a much later time, by the percussion cap, but its ballistic properties were always despicable, and its inaccuracy marvellous. The round ball had, for facility of loading, to be made considerably smaller than the bore, and much of the force of the powder was wasted, so that to produce the greatest effect it was necessary, early in the nineteenth century, just as much as late in the sixteenth, to reserve fire until the whites of the enemy's eyes could be seen. So late as 1798 one Richard Oswald Mason published a book advocating the arming of the Volunteer troops raised for the defence of the country at that time with the pike and the long-bow in preference to the musket.

Our purpose, however, is not to discuss the history of firearms generally, but only of that variety of them known as rifled guns, an early improvement, the history of which remains in great obscurity. The principle of rifling is generally understood. It is a means of giving to the bullet, by the time it leaves the mouth of the barrel, a spinning motion round an axis corresponding with the central line of the hollow cylindrical interior of the barrel. The flight of a bullet thus spinning on itself on an axis in the direction of its line of motion thereby develops two useful features—it maintains its position very nearly in that line (so far as gravity will permit), and if it have any irregularities of form or density it presents them on all sides successively as it revolves to the air obstructing it. Thus any tendencies to deviate in one particular direction, such as may arise from unsymmetrical form or weight, are made to cancel themselves by being converted into tendencies to deviate equally in all directions.

Precisely how early the attempt was made to give this spinning motion to the bullet we do not know. It is very likely that before the invention of grooving some attempt may have been made to spin the missile by feathering, as had long been done with the arrow. It is certain that, since the invention of rifle-grooving, many other devices to accomplish the same end have been tried, but all have proved quite inferior in simplicity and in practical results. The essence of rifling is grooving, cut spirally on the interior surface of the barrel, which, as the bullet is propelled forward by the force of the gases liberated by the explosion, grips it, and forces it to turn on itself. The spinning motion thus given continues during the flight of the bullet.

It seems to have been generally accepted by writers on the subject that the earliest rifled barrels had straight grooves, the object of which was to give a space into which the fouling of previous shots—always a difficulty—might stow itself without obstructing the process of loading with a well-fitting ball, and that spiral grooving was merely an accidental variation of this, afterwards found to possess special advantages. A passage from the town records of Leipsic in 1498, which has sometimes been quoted as giving colour to this supposition, and as alluding not only to rifles but to rifles with straight grooving, is found on examination not even to mention firearms at all. Major Angelo Angelucci, in his catalogue of the wonderful collection of armour and arms in the Royal Armoury at Turin, speaks of the mention in an inventory of arms of 1476 of *sclopetus unus ferri factus a lumaga,* which he interprets as signifying a firearm with the barrel spirally grooved. The claim for this early mention of the rifle in Italy does not appear to have been generally accepted, and it is not impossible that the word *lumaga* or *lumaca* may allude to the external shape of the barrel. The evidence of the early rifled barrels preserved in this country and on the Continent does not, so far as the writer knows, bear out the contention that the barrels as at first made had straight grooves. The earliest grooved barrel with a date on it in this country is one brought from Hungary in 1848, and now in the Museum at Woolwich. It is dated 1547, and there is no reason to suppose that the grooving, which is much worn, is not contemporary with the barrel. This barrel has spiral rifling. In the same collection, out of thirty-six rifled barrels of the sixteenth and seventeenth centuries, only three have straight grooving, and these do not appear to be the earliest. The specimens of rifled pieces in the Swiss collections seem to tell the same tale. In the National Museum at Zürich and in the local collection at Berne there does not appear to be any example of a barrel with straight grooves, though there are many early pieces with spiral rifling; so that it is by no means proved that the latter was an accidental discovery, arising out of a badly made attempt at straight grooving. It seems antecedently more probable that it should have been the outcome of a deliberate attempt to find a means of giving to the bullet the spiral spin which was well known as having a steadying effect on the javelin, or on the arrow or bolt discharged from a bow.

The invention of rifling has been attributed variously to Gaspard Kollner, of Vienna, in the fifteenth century, and to Augustus Kotter, of Nuremburg, in 1520. In the collection at Vienna are several rifles dated between 1550 and 1560, and some of the rifled barrels at Zürich seem clearly to be older than 1544, having already been in the arsenal at that date. There may no doubt be cases in which barrels originally smooth-bored have been grooved at a later time, but this is not at all likely to be the case with all the earliest examples known. Schmidt quotes, from the archives of Berne, a regulation made in 1563, dealing with complaints of the unfairness of using the grooved barrel in competition with the smooth-bore for target-shooting. It is quite clear that for sporting purposes rifles had come into favour in the latter half of the sixteenth century. From that time onwards many rifles were made, some ornamented with the richest decoration of inlay, carving, and embossed metal work that contemporary taste could devise.

The invention of rifling was certainly Continental, and not English, and the earliest reference to it in an English book, so far as we know, is made by Sir Hugh Plat, in his 'Jewell House of Art and Nature.' Writing in the year 1594, he gives many recipes which he had collected both for use in the household and on many other occasions of life, such as the making of what was called in after years 'sympathetic ink,' and of 'a delicate stove to sweat in,' that is, an arrangement for taking a Turkish bath at home. One of his recipes is as follows:

'How to make a pistol whose barrel is two feet in length to deliver a bullet point blank at eight score' (i.e. 160 yards). 'A pistoll of the aforesaid length and beeing of petronel bore, or a bore higher, hauing eight gutters somewhat deepe in the inside of the barrell, and the bullet a thought bigger than the bore, and is rammed in at the first three or foure inches at the least, and after driuen downe with the skowring stick, will deliver his bullet at such distance. This of an English Gentleman of good note and for an approoued experiment.'

Sir Hugh does not tell us whether the grooves were spiral or straight, and evidently did not appreciate the point; but it seems that they could hardly have been the latter, since the results were so striking in comparison with those of the smooth bore. He had not seen the pistol himself, apparently, and the rifle seems to have been quite a novelty in England at that time.

The earliest description which the writer has seen of the manufacture and use of the rifle by one who really understood it is contained in a Spanish book by Alonso Martinez de Espinar, entitled 'Arte de Ballesteria y Monteria,' published originally at Madrid in 1644, and reprinted in 1761. It is evident from this that by the middle of the seventeenth century the use of the rifle for sporting purposes was extremely well understood. A passage worth quoting runs as follows:— 'There are other arquebuses rifled within with grooves which generally make in the length of the barrel half a turn, or one turn, or a turn and a half.' After stating that both the pitch of the spiral, and the number, width, and depth of the grooves depend upon the fancy of the 'Maestro' or maker, and that the grooves may be either shallow and close together or deep with wider bands separating them, de Espinar proceeds:— 'These last are the best; and to have a greater or less number of them is a matter of taste, as has been already said, and similarly the question of the gun containing a large or a small ball. The most perfect is to have seven or nine grooves if the barrels be of 7 to 11 adarmes.[1] This is enough to kill the quarry with ball. In using a larger bullet one can put more grooves for it, for in this there is no fixed rule. But there must be a rule in knowing how to load them, for the greater power of these arquebuses over smooth bores consists in this, that the fire has greater resistance in the former kind of barrel, because it forces itself into the twists of the rifling, and because there is an obstruction in the passage through which it has to find its way it multiplies its force. And for this reason it should be observed that its force is increased by ramming down the charge. And it is necessary to have felt wads, cut with a punch, which must be exactly fitted to the mouth of the barrel. They must be pitched with Greek pitch (colophony), wax, and tallow. All this should be dissolved and the wads thrown into it, and after they have absorbed the pitch they must be put to cool, and then they remain very hard and greasy; these are very important indeed for rifled arquebuses, because with them the balls go in more easily, for they have to fit very closely to the barrel, having to be driven to the bottom by blows of the ramrod. And as they enter in this manner it is impossible to get them in for two shots running from the fouling which the powder leaves, and there is no other remedy but to wash the barrel. And that this may not be necessary, and that you may be able to fire as many as a dozen balls, these wads are applied, which drive down the fouling left by the powder, and leave the barrel clean and slimy with the pitch. And in the same way, the ball entering with so much pressure, helps to stop the windage of it, and in this consists the greater or less range that it has, according as the fire uses more of its force.' An illustration is appended (Plate I.) from de Espinar's book, showing a deer-drive and the sportsman shooting from under a tree, his weapon supported on a rest. The game is represented as being delightfully tame. The line across the picture shows the direction of the wind.

In the description just quoted we see all the difficulties of the muzzle-loading rifle appreciated, the chief being the uselessness of a loose ball and the difficulty of loading with

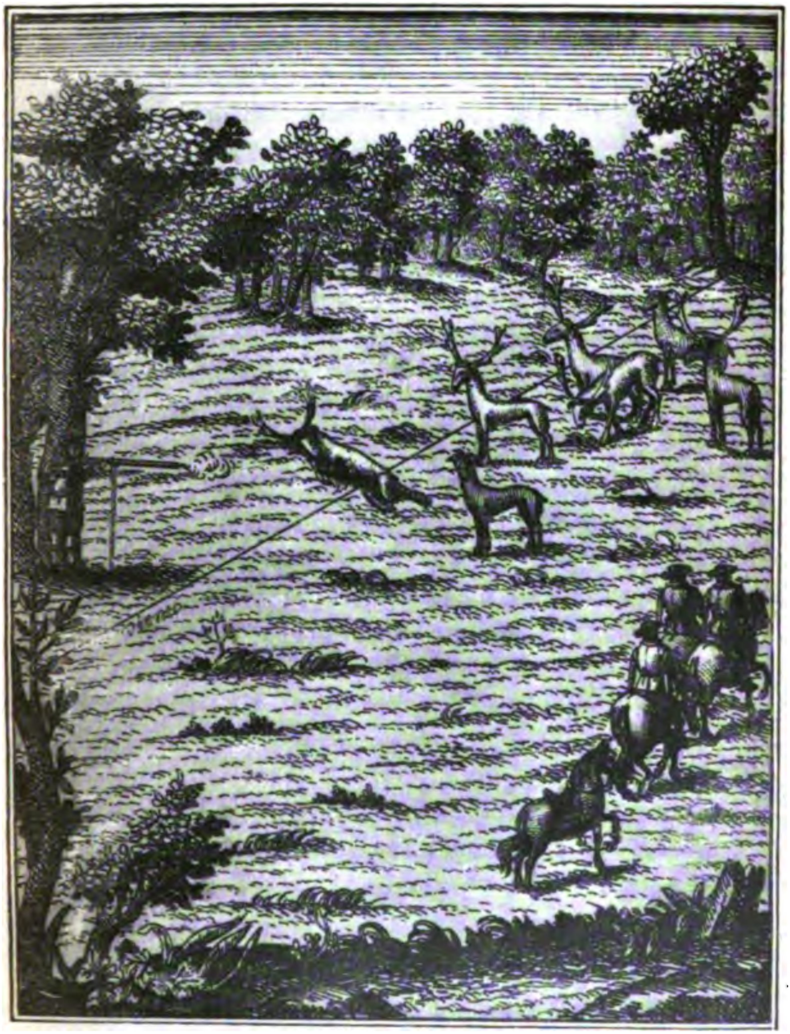
[1] The adarme = $\frac{1}{16}$ oz.

a tight one owing to the fouling, or residuum of the burnt powder, obstructing its passage. The use of a greasy or slimy wad, fitting very tight, palliates this trouble. The difficulty caused by the fouling, which made the rifle so much slower to load than the smooth-bore, was, no doubt, greatest in the earliest days when the ingredients of the powder were impure. It was not until the middle of the nineteenth century that improved methods and improved workmanship overcame the trouble, and the bullet itself was made effectually to clean the bore at each shot.

The earliest rifles seem usually to have had six, seven, or eight grooves, seven being the commonest number, possibly on account of its mystic properties. For these every sort of shape was tried. They were made with square corners or rounded, notch-shaped, ratchet-shaped, deep or shallow, according to taste.

The pitch or angle at which they were inclined from the straight line of the barrel varied similarly with the fancy of the maker, and depended on no accepted rule. The spiral grooving inside the barrel may be compared to a long strip of paper wrapped spirally round a smooth stick at no very steep inclination. If the end of the paper be held and the stick rolled upon a flat table so as to unroll the paper, it will be found that the precise angle of inclination of the strip of paper to the stick can easily be measured. In the same way the angle of the grooving in the barrel will be found to be such as to make either a portion of a turn, or a certain number of turns, in the length of the barrel. Naturally enough, the pitch of the spiral was commonly measured by its proportion to the length of the barrel—not at all a satisfactory method, since the length of the barrel varied, and so did the calibre. The simplest way to express the inclination is in terms of the calibre, which gives a true comparison between one arm and another. The earlier rifles at Woolwich usually show a pitch of from fifty to ninety calibres, but some of the seventeenth century a good deal more; one is a slow spiral of nearly 200 calibres. These rifles have mostly six to nine grooves. As we have just seen, there was no accepted rule as to the spiral in Spain when Alonso

PLATE I



DEER DRIVE, 1644

de Espinar wrote in the middle of the seventeenth century. In Deane's 'Manual of Fire-arms,' published in 1858, it is stated that the rifle in the previous century was used in Switzerland and the Tyrol for sporting purposes, the barrel being very heavy, and 'some were rifled with straight parallel grooves, but the majority in a spiral line, sometimes of half a turn, sometimes three-quarters of a turn, and seldom more than the whole turn in a length of 2, 2½, and 3 feet.' Early in the last century there seem to have been barrels made with straight grooves, but it does not seem to be certain that these were not usually for firing small shot. Robins, whose experiments on rifles are among the classics, writing about the year 1740, speaks of rifled pieces as being well known on the Continent, but little used in England, and says that though various degrees of spiral are used, it is usual for the rifling to make a little more than one turn in its whole length. He comments on the advantage of wrapping the ball in a tightly fitting patch of leather or fustian to make it fit the grooves. Baker, in his 'Remarks on Rifle Guns,' the first edition of which seems to have been published in the year 1800, says that 'it has always been considered that three-fourths or a whole turn in the angle of a rifle with a barrel 3 feet in length was best for throwing a ball with certainty. This mode of rifling is practised by Germans, French, and Americans, and all the foreign rifles that I have ever yet seen are rifled according to that principle; and several English gunmakers are firmly of opinion that one turn in 4 feet is the best angle possible. With this angle of rifling I never could fire at a long range with any degree of certainty.' He goes on to say that if he increased the powder-charge to get a greater range he found the bullet strip, *i.e.* pass over the grooving altogether; and as the result of experiments, he came to the conclusion that the nearer the grooving approximated to a straight line the more true and further the bullet would range. He found that he got excellent results from a barrel 2 feet 6 inches long, rifled with one-fourth of a turn in its length. Colonel Beaufoy, however, writing in 1808, puts in a strong plea for a more rapid spiral than this, *i.e.*, three-fourths of a turn in the length of the barrel. It had been observed that the accuracy of the rifles made with the more gradual twist fell off rapidly when they were fired at anything approaching long ranges, and Colonel Beaufoy states that some of the foreign makers had adopted with success a more rapid twist. He says:—'Guns having accordingly been constructed on this plan, they were first of all (we believe) adopted in the Duke of Cumberland's Sharpshooters,' now the Victoria Rifles, 'where they were found to answer so well that all their crack shots, and such as were fond of the sport, abandoned their old barrels, and procured others on the new plan, which was that of three-fourths.' The new rifles were made by Mr. Smith, of Lisle Street, from suggestions by Mr. Francis de la Pierre, of Hackney. The superiority of the new rifles was so conclusively proved in a match that they were generally adopted by the other corps.

We give a copy of a curious old print published in 1811 representing a match between the Duke of Cumberland's Sharpshooters and the Nottingham Robin Hood Club, in which the score of the latter was 18, and of the former 31. It is stated on the plate that 'the Notts took 2 hours and 40 minutes to fire their shots in order to draw the Cumberland into the night, but the Cumberland fired theirs in 43 minutes, beginning at a quarter past five.' This match appears to have been shot on Stamford Raceground. It is, unfortunately, not stated what was the distance and what the number of shots. The shooter's figure is well drawn and the attitude characteristic. The plate was evidently drawn by a partizan of the Cumberlands to commemorate their victory, and is, perhaps, rather unkind to the Robin Hoods.

The system found so satisfactory was taken up by other gunmakers, and further developed. Mr. Squires, of Whitechapel, went so far as to give the grooves a complete turn in the length of the barrel, and this was attended with even greater success. When, however, he tried the effect of having two turns of spiral in the length of the barrel, it appeared that, although these rifles shot well, no sufficient advantage was gained to bring them into general use. It

RIFLE MATCH BETWEEN THE DUKE OF CUMBERLAND'S SHARPSHOOTERS AND THE ROBIN HOOD RIFLES, 1811

seems to be clear that on the Continent a rapid twist had been used where it was desired to obtain good results at long ranges, but it is evident that at this period a rapid twist was not compatible with a very high velocity. Colonel George Hanger, in his book, published in 1814, speaks of the American rifle as being made with one whole spiral turn in the barrel, which was 39 inches long. As this proportion was found most satisfactory by the Americans a hundred years ago, as well as by Continental nations, it must have had much in its favour.

One of the great advantages of the two-grooved rifle, carrying a round ball with a belt cast on it, which fitted into two deep grooves, was found to be that a more rapid degree of twist could be given to the bullet without its stripping. This was the principle on which the Brunswick rifle, which in 1839 succeeded the Baker rifle as the arm of the Rifle Brigade, was made. It had a spiral making one complete turn in 30 inches—just four times as rapid as that of its predecessor.

Wilkinson, in his 'Engines of War,' in speaking of the increased pitch of spiral, says that it was almost impossible with the ordinary spherical bullet to give a more rapid spiral than one turn in three feet without causing the bullet to strip. On the other hand, Lieut. Forsyth, in his book on 'The Sporting Rifle and its Projectiles,' published in 1863, speaks of the importance, from a sporting point of view, of the spherical ball as having a larger striking surface than a conical one of the same weight, and of the great improvement which a Scotch gunmaker made in 1851 by reducing the spiral from the established rates to one turn in ten or eleven feet, which was found to be perfectly sufficient for sporting distances. Captain Forsyth's conclusion was that a 14-bore barrel, rifled at the rate of one turn in 8 feet 8 inches, would give all necessary accuracy up to 200 or 250 yards, and that with a similar rifle a rate of spiral of one turn in 12 feet would give accuracy up to 150 yards, these being the furthest distances required for sporting purposes.

It should be observed that the pitch of the spiral depends to some extent upon the velocity to be given to the bullet.

In any rifle with a small charge a rapid twist may be used, because there is less danger of the bullet being forced over the lands of the rifling, and because its rapidity of spin after leaving the muzzle, on which its stability depends, is compounded of two factors, the velocity and the rate of twist of the grooving, of which when one is diminished, the other needs to be proportionately increased. It would seem that a moderately rapid spiral was rather the rule than the exception with the earliest rifles. One reason for this may probably have been the inferior quality of the powder, and another the insufficient strength of the barrels, which limited the charge used and also tended to a low velocity. Under such conditions a quick twist could be used. It was when the velocities began to be much increased, as in Captain Forsyth's day, to obtain a flatter trajectory that the danger of stripping with the spherical ball became most prominent. A ·303 rifle has a spiral of about one turn in thirty-three calibres; it is actually one turn in ten inches. The largest cannon that are made have a spiral of very similar pitch, about one turn in thirty calibres; and with a similar velocity tho strain on the bullet, which arises from its being suddenly twisted upon itself, is not greater in the one case than in the other. At the same time it is clear that the distance in which the spiral makes a complete turn in the rifle is very short.

The battle of the spirals was a long one, and most obstinately fought. It found a definite solution only in the latter half of the nineteenth century, when the invention of the elongated bullet rendered it possible to use a very rapid spiral without its stripping, since even a short cylindrical part near the base obtained much more holding surface upon the grooves than a spherical ball.

Sir Joseph Whitworth's famous experiments about 1860 threw much light on the question of the spiral. In the course of his researches he investigated the twist of the Enfield rifle, ·577 bore (one turn in 78 inches), and found that this was not enough to steady in flight a longer bullet than that of the Enfield rifle. But he found that there was no difficulty in firing with a barrel rifled with one turn in 30 inches, a spiral similar to that previously adopted by

General Jacob, and as he had reduced the bore to ·450 inch, he tried barrels with one turn in 20 inches, one turn in 10 inches, one turn in 5 inches, and, finally, even with one turn in 1 inch. These barrels were of his hexagonal bore, and the bullets were shaped to fit them, and hardened. With a bullet spinning once in every inch of progressive flight, and a charge of 35 grains of powder, he succeeded in penetrating seven inches of elm planks.

He did not express the pitch of the spiral in terms of the calibre, but came, as he says, to the conclusion that 'the twist for a rifled-musket bullet must not be less than one turn in 20 inches, the minimum diameter of the barrel being ·45 inch; this construction gives the best shot with the charge of powder and weight of bullet to which I was limited.' This twist, it will be observed, amounts to one turn in a length of 44·4 times the calibre of the barrel. A spin somewhat more rapid than this is found suitable for modern rifles, large and small, in which the length of the projectile in proportion to the calibre is considerably greater than was the case with the bullet adopted by Sir Joseph Whitworth. Fig. 1

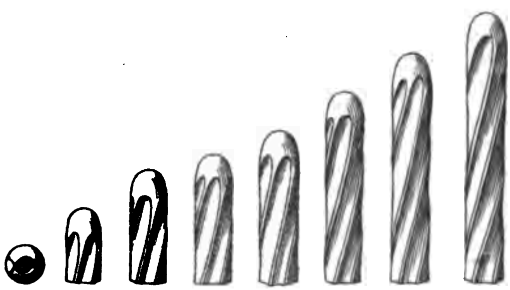


FIG. 1

shows, on a reduced scale, bullets of various lengths tried by him.

The extreme trial which he made of spinning a bullet once in every inch of the length of the barrel, demanded quite a small charge on account of the resistance of this great angle of rifling to the progressive motion of the bullet. We all know that, to take the analogous case of a top spinning, a certain degree of velocity of spin is required to keep it upright and apparently motionless upon its point, and that if the spin be insufficient it swings round and round while it is spinning. In the days of the spherical bullet the ingenuity of gunmakers was taxed to reconcile two conflicting requirements; to give the bullet sufficient spin for steadiness, and to give the rifling such a pitch of angle as would neither cause the ball to strip nor unduly reduce its velocity by checking its progress in the barrel. To the latter point far too much importance has habitually been attached. It is true that the velocity of a bullet made to twist in the grooving of a rifle will be in some small degree lessened as compared with that of one discharged from a smooth-bore; but with shallow grooving and a hardened bullet, such as have now for many years been used, the difference is very slight, while some degree of compensation is derived from the fact that owing to any delay caused in the passage of the bullet the powder gases will have a longer time in which to act upon it. So evidently is this the case that one of the early theories to explain the fact that the rifle did more effective work at longer range than the smooth-bore, was that the increased resistance given by the grooving caused more force to be developed by the charge. Even in such recent times as those in which the modern 'Express' rifle was produced, it has been thought that a distinct advantage in velocity could be gained by giving as little inclination as possible to the spiral, though it does not seem that any benefit thus obtained would be appreciable.

The late Mr. Metford, whose lifetime of study and experiments with the rifle lend very great weight to his opinion, estimated that in the normal pattern of his rifle, in which the velocity was 1,300 feet per second, given by means of an increasing spiral ending with one turn in 34 calibres, the loss of velocity due to the rifling of the bullet would not be more than about five feet per second.

It was very natural that those who were groping in the dark in the pre-scientific ages of rifle-making, and had no principles to guide their experimental work, should try every variety of grooving in the hopes of hitting upon some improvement. That they did try almost every device which could possibly suggest itself is cleár. The polygonal bore, which had been proposed in its hexagonal shape by Sergeant-Major Moore, R.A., in 1839, and had been experimentally made in octagonal form for Sir Isambard Brunel, the engineer, some years before Sir Joseph Whitworth adopted hexagonal rifling, is an invention dating back far beyond the nineteenth century. In the collection of arms at Geneva, for instance, there is an old rifle whose bore has a square section. At Woolwich there is a rifled arquebus, the barrel of which was made by Augustus Kotter of Nuremburg, which has a polygonal rifling of seven grooves.

So, too, the degree of spiral was occasionally varied. There exist specimens of ancient arms with barrels rifled with a twist which is slow at the breech and increased towards the muzzle; with a twist which is rapid at the breech, and becomes slow at the muzzle; and, still more marvellous, with a spiral which, beginning slowly, is most rapid in the middle of the barrel, and decreases again before it reaches the muzzle. Such cases as the latter seem more probably due to inadequate tools or careless workmanship than to design.

There can be no doubt that if it be worth while to have an increasing spiral, the principle upon which Mr. Metford devised his is the correct one—that the bullet should receive during its passâge up the barrel an equal increment of twist in each equal space of the time during which it is under the powder's pressure. By considering the expansion of the gases a curve can be drawn which shows the increase of velocity in each moment of time, and this was the foundation upon which the curve of the increasing rapidity of his spiral was laid down by Mr. Metford. He maintained, and with justice, that such an increasing spiral brought the smallest amount possible of strain to bear upon the bullet. But the practical complications of manufacture and repair which an increasing spiral involves have not been found to be compensated by any appreciable advantage even with the much higher velocities now given to the bullet. Nor is it so suitable to a hardened bullet of great length in proportion to the calibre as to the softer and shorter bullets of the black-powder arms.

Other means of spinning the projectile have often been tried besides grooving. We have seen an arrangement fitted experimentally to a smooth-bore barrel, probably about the year 1860, which was said to have given very good results up to 500 yards, but not further. This consisted of a small square stem, a little more than one-tenth of an inch in diameter, which screwed into the bottom of the breech so as to project about 5 or 6 inches up the barrel; it was slightly twisted, and its end pointed, and the bullet, which was cast with a square hole in it to correspond, fitted upon the stem, and was driven down upon the powder at its base. On being fired the bullet passed along the twisted stem, and this gave it a rotation which continued after it had left the muzzle of the smooth-bored barrel, and kept it steady for a certain distance in flight. The complication, however, of such a device as this, compared with the normal method of giving rotation to the bullet, quite precluded its general adoption. Endless attempts have been made to give rotation to the bullet, or to aid rotation already given in the barrel, by spiral grooves cut upon the bullet itself. But they have all failed, the nearest approach to success being a bullet for sporting purposes brought out some twenty or twenty-five years ago by Dr. Macleod. This bullet was of a cylindrical shape, and was pierced with four taper holes round its axis; the holes had a spiral inclination, and in this way imparted to the bullet a rotation which was sufficient to steady it for a flight of about 100 yards. Rotation given in this way is always obtained at a heavy cost in velocity, and in this case the heavy resistance which the bullet met with owing to its flat head, the flat head itself being a great factor in steadying the bullet, rendered it quite ineffective beyond that distance. The loss of accuracy between 100 and 120 yards with this bullet seems to have been somewhat remarkable.

It would be of no use, and of little interest, to enumerate other methods which have been devised for effecting the same end, such as the proposal that the projectile should be made hollow, and fitted over the outside of the barrel, or that it should be made in the shape of a narrow disc, and be given a similar spin to that which a stone has when sent skimming over the water with the hand. A more modern notion, but one equally unpractical, has been that of firing a smooth-bore cannon, and giving to the whole cannon a rapid rotation at the moment of firing, a rotation which the shot on leaving the muzzle would, of course, retain. Consider for a moment what engine-power and mechanism would be required to give rotation to a heavy cannon at a speed of several hundred turns in one second, when adjusted in any direction, without shaking it so as to spoil the aim, and (if it be possible) without interfering with rapidity of loading; remember, too, that the desired movement can, in fact, be instantaneously given at the instant of firing, without any mechanism or added weight; you will then understand what wildly ignorant ideas can sometimes assert themselves in the daily press as practicable improvements.

No better method, in short, has been invented than what, so far as we know, is the earliest means of all, as it is certainly the simplest, the spiral grooving of the barrel, whereby the spin is given to the projectile in the course of its propulsion.

CHAPTER II

EARLY MILITARY RIFLES—ROBINS'S PROPHECY—THE WAR OF INDEPENDENCE—THE RIFLE BRIGADE—THE BAKER RIFLE—COLONEL HANGER—THE BRUNSWICK RIFLE—SLOWNESS OF LOADING—EXPANDING BULLETS—PICKET BULLETS—MINIÉ BULLET AND RIFLE—TRIALS IN 1852—GENERAL JACOB—THE ENFIELD RIFLE—WHITWORTH'S EXPERIMENTS

The history of the rifle as a military weapon in continuous use does not begin much more than a hundred years ago, although many attempts to introduce it for troops were made at different times in the seventeenth and eighteenth centuries. Perhaps the earliest was the arming of some of the Danish troops at the beginning of the seventeenth century with the rifle. A number of these arms are still in the Arsenal at Copenhagen, and one is in the collection at Woolwich. The barrel is dated 1611, and is marked with the cypher of Christian IV. At the end of the Thirty Years' War the Elector Maximilian is said to have introduced rifled firearms into the Bavarian army, and Marshal Puysegur recommended the adoption of rifled muskets as the arm of a small proportion of the men in each company in the French infantry of his time. Louis XIII. established a carbineer cavalry regiment, which was armed throughout with rifled carbines, and a certain number of rifles were issued for distribution among the infantry.

In a small book called 'A Treatise of Arms,' written by Louis de Gaya, and published at Paris in 1678, and two years later translated into English, illustrations are given both of the straight-stocked musket, with match or flint lock which is placed against the breast when fired, and of the firelock with a crooked stock, with which a proper aim could be taken along the barrel; and also of the mousqueton, which is the short form of the firelock; and 'does not by a third part carry so far unless the barrel be screwed and rifled'; and of the carbine, the chief distinction of which was that it had a wheel lock. De Gaya speaks further of 'extraordinary carbines (arquebuses guttières),' which have a more rapidly acting lock and a thicker barrel than any carbine, and 'can carry blank about 1,000 paces with the same proportion of powder as is necessary for the fusil, because it is screwed and rifled, that is to say, wrought and crevassed in the inside from the muzzle to the breech in the form of a screw, and from thence proceeds the justness of harquebuses.' He clearly shows that it was the usual arm of the French troopers of his day. We may observe in passing the delightful ascription to this short rifle of a 'point-blank' range of 1,000 paces, a claim which is hardly more wonderful than the similar one so often made nowadays for rifles of modern make. In those days even more than in these such a statement could rest only upon a very flimsy substratum of fact.

It is a curious fact that Mr. Grose, in his book on 'Military Antiquities,' in which he gives a history of the English army and of military weapons in this country from the Conquest, until the date at which he wrote, 1786, does not even mention the rifle as a weapon. At that time, indeed, it had never been seriously made use of in the British army, although as long before as 1742 Benjamin Robins, in his 'New Principles of Gunnery,' had ventured so far into the region of prophecy as to pronounce that 'whatever State shall thoroughly comprehend the nature and advantages of rifled barrel pieces, and having facilitated and completed their construction, shall introduce into their armies their general use, with a dexterity in the management of them, will by this means acquire a superiority which will almost equal anything that has been done at any time by the particular excellence of any one kind of arms, and will perhaps fall but little short of the wonderful effects which histories relate to have been formerly produced by the first inventors of firearms.' Prophecy is proverbially dangerous. Yet when we consider first the general adoption, and then the improvement of the rifle and of cannon, by which fire effect and fighting tactics have been entirely revolutionised, we must place Robins among the true seers. So questionable was it considered by military opinion whether the rifle gave on the whole any advantage at all over the musket, that Napoleon is said to have withdrawn the rifle from a part of the French light infantry, to whom it had been issued in 1793, during the wars of the Republic, and we hardly hear of it again as being used by the French until 1830.

The great objection to the rifle arose, as we have already seen, from the difficulty of loading it, and its consequent slowness of fire. Colonel Beaufoy, in his book 'Scloppetaria,' in 1808, says frankly that 'a musket will fire three shots to one from a rifle, as generally used.' Nearly all fighting was still at such close quarters as to make it more important that the firearm should be useful in preparing for bayonet work on the offensive, or in breaking the force of a charge before it reached the bayonets on the defensive, than that its fire at long range should be accurate. Then as now, speed of fire was a governing factor. It is only as speed has become combined with accuracy at a distance, that the old pike-tactics, which have in a large measure been continued by the bayonet, have given way. The firearm is now no mere auxiliary, as it used to be, to the bayonet. Yet there never was a time when the rifle in skilful hands could not produce striking effects in war.

The present writer, in a little book published some years ago, drew attention to a passage in the 'History of the War in America between Great Britain and her Colonies,' published in Dublin (1785), which shows the value given in America to skilled shooting with a rifle at that time. Lieut.-Col. Ferguson was an active and capable officer who met his fate in 1780, when sent by Lord Cornwallis on an expedition into North Carolina with a corps of light infantry, and a body of militia of his own training. 'The fall of this officer,' says the work above referred to, 'who possessed very distinguished talents as a partisan, and in the conduct of irregular warfare, was, independently even of his detachment, no small loss to the service. He was, perhaps, the best marksman living, and probably brought the art of rifle shooting to its highest point of perfection. He even invented a gun of that kind upon a new construction, which was said to have far exceeded in facility and execution anything of the sort before known; and he is said to have greatly outdone

PLATE III

DIAGRAM OF SHOOTING MADE WITH A BAKER RIFLE 1800

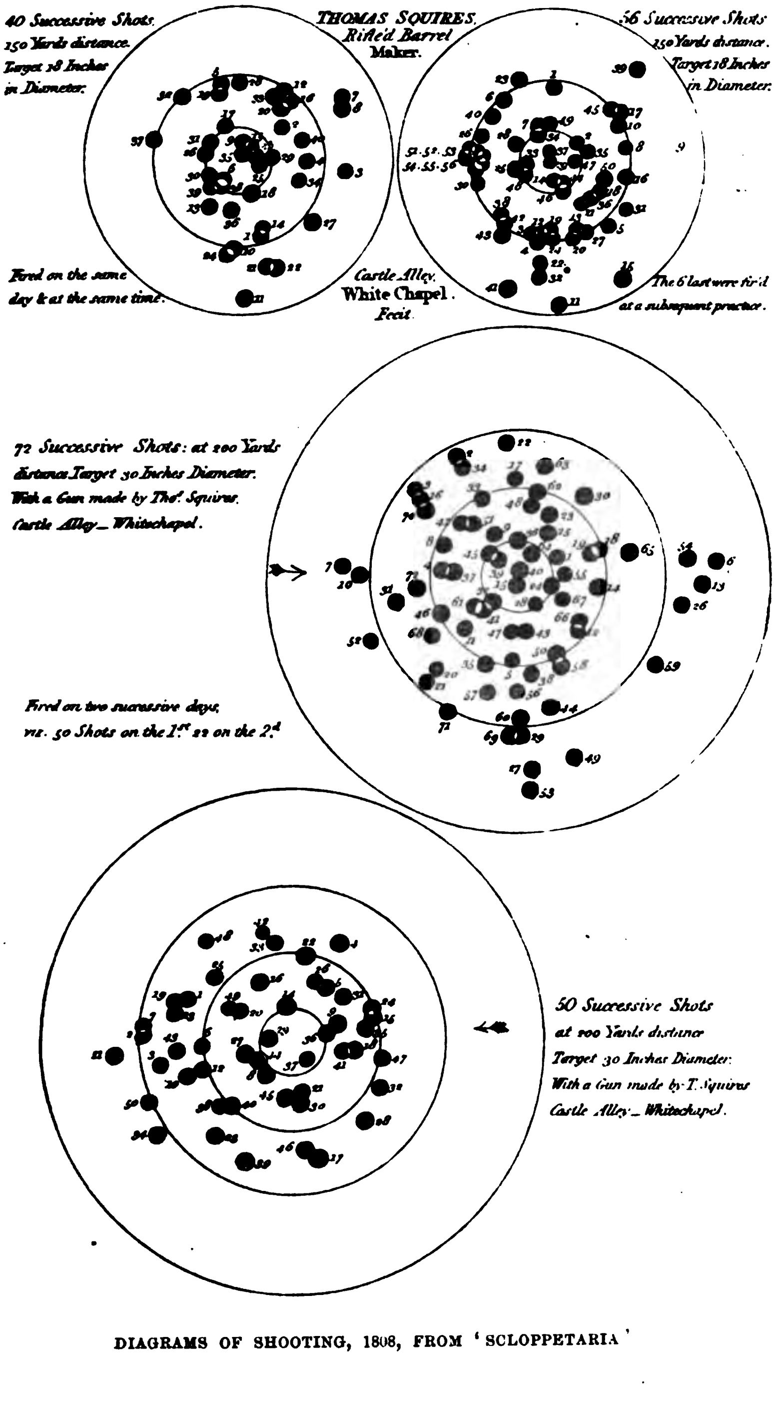
even the American Indians, in the adroitness and quickness of firing and loading and in the certainty of hitting the mark, lying upon the back, or belly, and every other possible position of the body. It is not certain that these improvements produced all the effect in real service which had been expected, from those astonishing specimens of them that were displayed in England. Humanity cannot, however, but wish that this barbarous mode of hostility was by universal consent banished from the warfare of all nations. It has been reported that George Washington owed his life at the battle of Germanstown to this gentleman's total ignorance of his person, as he had him sufficiently within reach and view during that action for the purpose.'

In order to meet the skill of the American backwoodsmen in this war, Jägers, were recruited on the Continent and sent over by the British Government to assist the British troops. It was, no doubt, this which suggested the raising of a rifle regiment. The 95th, Rifle Brigade, was raised by Colonel Coote Manningham early in 1800, and careful trials were made of rifles with a view to arming it. Not only the rifles of English gunmakers, but others from America, France, Germany, and Holland, were tried by the Committee which dealt with the subject. One made by Ezekiel Baker, of London (Plate V. fig. 1), was approved by the committee and adopted, and was the arm of the Rifle Brigade until 1837 or 1838. It had a barrel 2 feet 6 inches long, and was rifled with seven grooves making one quarter of a turn in the length of the barrel; the bullets weighed twenty to the pound (·615-inch calibre), and the rifle itself 9½ lbs.; it was sighted for 100 yards, and had a folding leaf giving an elevation for 200 yards. It was not an easy rifle to load, as the bullet, though wrapped in a piece of greased rag (a supply of which was carried in a brass box in the stock of the rifle), required some force to make it enter the barrel. For this purpose a small wooden mallet was used to drive the ball into the rifling, in exactly the fashion already quoted from Sir Hugh Plat, and it was then forced home by a heavy ramrod. The mallets were soon found to be inconvenient, and their use was not continued for more than two or three years. The Baker rifle had, of course, a flint lock, and the rifleman carried a picker to clear the touch-hole, and a little brush to clean the pan. A triangular sword bayonet 17 inches long was carried, and had a spring attachment to the rifle.

The performances of this rifle may be judged from Baker's book, 'Remarks on Rifle Guns,' which shows that he thought it good work to hit the figure of a man in 20 or 30 shots consecutively at 100 or 200 yards, as shown in Plate III. He does not mention whether the rifle was fired from a rest or in a standing position; probably the latter, for Colonel Beaufoy shows some much better targets of about the same date (Plate IV). The coloured diagrams which Baker gives to illustrate the positions of firing are decidedly curious, and have been several times reproduced in more modern works. Yet we give them again further on, for they are of some historical interest. The Rifle Brigade, armed with the Baker rifle, was found to be such a useful body that a second battalion was raised in 1805, and the regiment formed a prominent part of the famous Light Division in the Peninsular War.

Meanwhile attention continued to be directed to the importance of the rifle in the light of Transatlantic experience. There were many Englishmen who had seen service in America and learnt what a formidable weapon in the hands of a skilled shot a rifle could be. Colonel Hanger, who was one of them, relates an instance bearing on the point. Writing in 1814, having served during the war as a captain in the Hessian Jäger Corps, he says that he never in his life saw better rifles, or rifles better used, than those made in America, and adds that they were chiefly made in Lancaster, and two or three neighbouring towns in that vicinity, in Pennsylvania. Their barrels, he says, weighed about 6 lbs. 2 or 3 oz., and carried a ball not larger that 36 to the pound. This is equivalent to a diameter of a little more than half an inch, a smaller calibre than was used in the military arms of this country until the adoption of the Martini-Henry rifle. Yet Colonel Hanger says that he never saw in America a rifle of larger calibre than has just been mentioned, although he had seen many hundreds. He gives the following account of an incident in the war, showing that the use of the rifle at a

PLATE IV



DIAGRAMS OF SHOOTING, 1808, FROM 'SCLOPPETARIA' distance of 400 yards was unusual in those days, and taken to be a very important developement in war:—'Colonel, now General Tarleton, and myself, were standing a few yards out of a wood, observing the situation of a part of the enemy which we intended to attack. There was a rivulet in the enemy's front, and a mill on it, to which we stood directly with our horses' heads fronting, observing their motions. It was an absolutely plain field between us and the mill; not so much as a single bush on it. Our orderly-bugler stood behind us about three yards, but with his horse's side to our horses' tails. A rifleman passed over the mill-dam, evidently observing two officers, and laid himself down on his belly; for in such positions, they always lie, to take a good shot at a long distance. He took a deliberate and cool shot at my friend, at me, and the bugle-horn man. Now observe how well this fellow shot. It was in the month of August, and not a breath of wind was stirring. Colonel Tarleton's horse and mine, I am certain, were not anything like two feet apart; for we were in close consultation, how we should attack with our troops, which laid 300 yards in the wood, and could not be perceived by the enemy. A rifle-ball passed between him and me; looking directly to the mill I evidently observed the flash of the powder. I directly said to my friend, 'I think we had better move, or we shall have two or three of these gentlemen, shortly, amusing themselves at our expence.' The words were hardly out of my mouth when the bugle-horn man behind us, and directly central, jumped off his horse and said, 'Sir, my horse is shot.' The horse staggered, fell down, and died. He was shot directly behind the fore-leg, near to the heart—at least, where the great blood vessels lie, which lead to the heart. Now, speaking of this rifleman's shooting, nothing could be better; but, from the climate, he had much in his favour. First, at that time of the year, there was not one breath of wind; secondly, the atmosphere is so much clearer than ours, that he can take a more perfect aim.' 'I have passed,' he adds, 'several times over this ground, and ever observed it with the greatest attention; and I can positively assert that the distance he fired from, at us, was full four hundred yards.'

Colonel Hanger[1] proposed to arm English troops with a rifle of new design, suggested by his American experience, having a heavy barrel of small calibre, to enable a bullet to be fired with specially high velocity.

In 1836 the improvements in rifles were thought to justify a change in the arm of the Rifle Brigade, and a Board was assembled at Woolwich to deal with the subject. It was only after trials extending over several weeks that the Brunswick rifle (Plate V., fig. 2) was selected. This rifle had ignition on the percussion principle. Its barrel was 2 feet 6 inches long, and was rifled with two deep rounded grooves, making one complete turn in the length of the barrel: the bore was larger than that of the Baker rifle, carrying a ball twelve or thirteen to the pound, and being ·704 inch in calibre, not much smaller than the old 'Brown Bess.' It weighed nearly two pounds more than the Baker rifle, 11 lbs. 5½ oz., and was sighted to 300 yards. It was considered to make as good shooting at 300 yards as the Baker rifle had made at 200 yards. This was, no doubt, largely due to the more rapid pitch of the spiral. The ball fired from it was what is known as a belted ball, having a raised belt projecting all round it, which fitted the two grooves in the rifle-barrel. To aid the fitting of the belt to the grooves in loading, a notch was cut across the muzzle, which served to guide the belt into the entrance to the grooves. This rifle was fitted with a straight sword in place of the bayonet. As had been the case with the Baker rifle, it was found that loading became very difficult after a few shots, owing to the accumulation of the fouling.

The Brunswick rifle did not hold its own for many years. A Select Committee on Small Arms, 1852, reported as follows in reference to it:—'The Brunswick rifle has shown itself to be much inferior in point of range to every other arm hitherto noticed. The loading of this rifle is so difficult that it is a wonder how the rifle regiments have continued to use it so long, the force required to ram down the ball being so great as to render any man's hand unsteady for accurate shooting. Comment is unnecessary.'

[1] Colonel Hanger was an original. He absolutely refused to assume the title of Baron Coleraine, to which he succeeded on his brother's death in 1814.

During the Kaffir War of 1846 to 1852 a few Lancaster rifles (Plate V., fig. 3) were issued to the 1st Batt. Rifle Brigade in South Africa. They were generally similar to the Brunswick rifle, but carried a conical bullet with a flat base, and a rib on each side to fit the grooving. This was a very heavy bullet, and the flight was not very certain, but the rifles were sighted to 900 yards, and seem to have done good work. With this exception the Brunswick rifle lasted until the regiment embarked for the Crimea, when it was armed with the Minié rifle, which was then being issued to the line regiments.

It may be said on the whole that the improvements made in rifles since they have been recognised as serviceable in war are due to their developement in that capacity, and not as sporting weapons. We have before alluded to the obstacle which for so many years had almost prohibited the use of the rifle in war—the accumulation of fouling, owing to which the bullet could not be driven home, except with immense difficulty, after a very few shots had been fired. The ordinary musket used by the troops was free from this defect, because the ball was so much smaller than the size of the barrel that it would drop into it very easily. A gap was thus left, known as windage, between the bullet and the barrel, which wasted a good deal of the power of the powder, for the powder gases could leak out freely round the bullet as it went up the barrel. The accumulation of fouling on the surface of the bore after a few shots had been fired helped to fill up this space, but if the bullet was small enough in proportion to the bore a great many rounds could be fired before any difficulty was experienced in loading.

The musket is not generally looked upon as a weapon with which very rapid practice could be made; something like two shots a minute seems to have been the speed which could be reached. How much slower the rifle was in loading is shown by Colonel Beaufoy, who puts the time necessary to load a rifle at from 1½ to 2 minutes. Yet he considered the difference in accuracy to be so enormous, that, even allowing the musket a superiority of 5 to 1 in the rate of fire, it might be said that at from 250 to 400 yards the rifle

FIG. 1. BAKER RIFLE, 1800

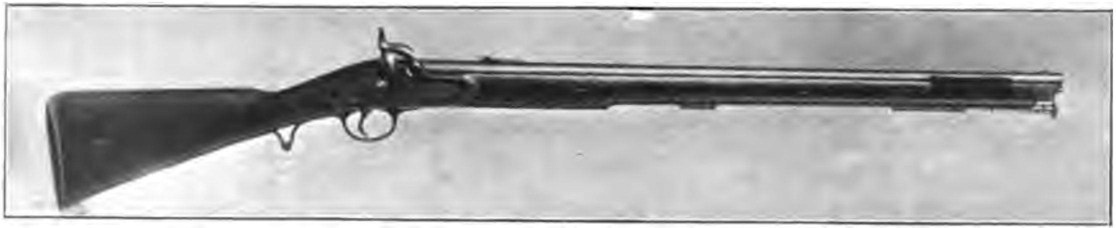


FIG. 2. BRUNSWICK RIFLE, 1836

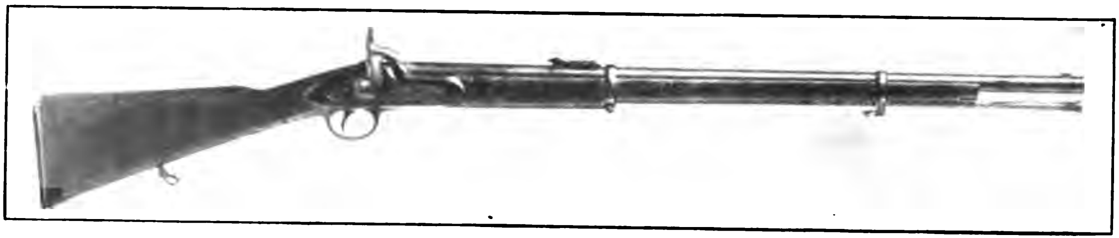


FIG. 3. LANCASTER RIFLE, 1846

D

would still be more effective than the musket in the proportion of 7 to 1. The great difficulty which had first to be overcome was the labour and trouble of loading with a bullet which required to be forced into the grooving, and it was not until the invention of the expanding bullet, which came after that of ignition by percussion, that this was satisfactorily accomplished.

A strong claim to have devised the first expanding bullet, that is, a bullet which was small enough to drop easily down the bore, and yet was expanded by the explosion so as to fit it properly, has been made by W. W. Greener, who produced, in 1835, an oval ball with a tapered hollow in it, into which a plug of similar shape, with a head like a round-topped button, was driven by the explosion (fig. 2). This bullet was tried in the same year by a party of the 60th Rifles, but the trials did not convince the military authorities of the day that it was advisable to adopt it. Mr. Greener's expanding bullet seems to have been devised with special reference to its use in the smooth bore. In 1841, describing the ball made by him in 1836, he speaks of its expanding, and 'thus either filling the grooves of the rifle, or destroying the windage of the musket, as the case may be,' and goes on to say: 'As regards its application to rifles, there can be no question of its advantage, if there exist any requirement for a ball to be acted upon by the grooves at all, which we do not think is advantageous—in fact, there exists no question.' It is only fair to say, however, that Mr. Greener's book, published in 1835, shows a considerable appreciation of the possibilities of the rifle, and criticises a current American idea that it really gave no advantage over the smooth bore. The essential virtues of rifling had very slowly begun to be understood. The very able author of 'Scloppetaria' had maintained that the bullet spun merely by virtue of the spiral impressions which its surface had received from the grooving, and which were acted upon by the air.

FIG. 2

Much ingenuity had been expended in France upon the subject, and M. Delvigne, in 1826, had brought to the notice of the French military authorities a new device for effecting the expansion of the bullet. His method was to use an ordinary round bullet of the soft lead then universally employed, which would easily fall into the barrel, but to make the powder chamber smaller than the rest of the bore. This gave a circular ledge above the powder charge, upon which the ball rested when dropped into the barrel; if then a few blows were given upon it with a heavy ramrod, the upper surface of the ball was slightly flattened, and it was expanded laterally until it fitted the grooving (fig. 3). By this means loading became a very rapid process, not materially slower than it was with the musket, and M. Delvigne at once obtained a very much greater precision of fire.

In 1833 Lieut.-Colonel Poncharra proposed to modify the Delvigne system by wrapping the ball in a thin greased patch, to keep the grooving clean, and subsequently the patch was fastened to a small sabot, or wad of wood, which was interposed between the ball and the shoulders of the powder-chamber (fig. 4). In 1838 this rifle was made the arm of the first experimental company of Chasseurs-à-pied, expanded in 1840 into the Tirailleurs de Vincennes, who made a great mark in Algeria in the operations against the Arabs, and became the nucleus of an establishment of ten battalions of riflemen.

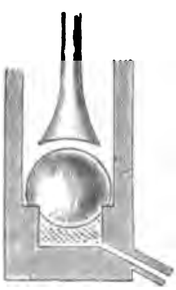


FIG. 3

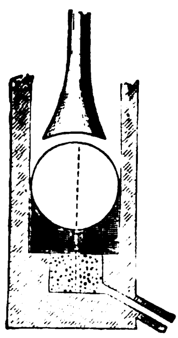
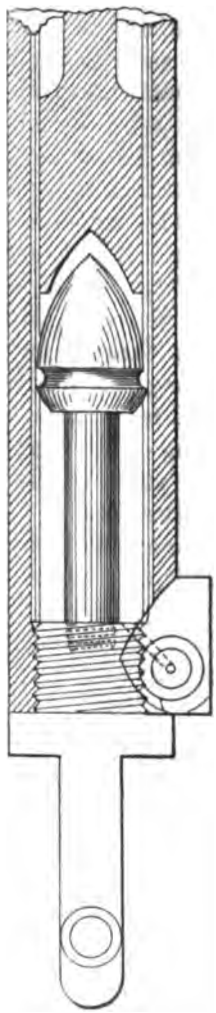


FIG. 4

Yet it was not found that this principle of loading was entirely satisfactory. The ammunition was rather complicated to make, and the difficulty which thus arose led Colonel Thouvenin, of the Artillery, to attempt an improvement upon it. His device was to introduce a short pillar in the middle of the breech, round which the powder lay, and upon which the bullet rested while it was expanded by ramming (fig. 5). There was, however, no great advantage in this alteration so long as the spherical bullet, insisted upon by the military authorities, was retained.



IG. 5

The round bullet, as has been shown, had several disadvantages. It was impossible to give it sufficient velocity of rotation to maintain its speed for a long distance, because the grooving could only catch hold of quite a small section of the bullet's surface, however well it might fit the barrel. If the velocity of projection was high, the pitch of the spiral had to be very slight. Otherwise the bullet stripped, passing over the grooves instead of along them. The rotation was thus insufficient to keep the bullet true for a long distance. Another drawback here comes in. The range for accurate shooting with the round bullet was further limited by the fact that its axis of rotation retained the original direction even when, owing to the curve of the trajectory, the bullet was moving at a very different angle. With the long bullet of modern days, which keeps its point in the direction of the curve of the trajectory, the tendency to deviate from the proper line of flight does not increase so long as the spin is maintained. The round ball, on the other hand, when beginning to fall, no longer cuts the air with its spinning end, so to say, but with the side, and consequently, instead of opposing to the resistance of the air a symmetrical axis, tends, as the range becomes longer, more and more to roll upon the air. Mr. Baker, who only a hundred years ago thought it necessary to try careful experiments to prove that a side wind does affect the flight of the bullet, speaks of 200 yards as the greatest range he could fire at 'to any certainty'; and adds that at 300 yards he has fired very well at times, when the wind has been calm, and that at 400 and 500 yards he has frequently fired, and sometimes struck the object. But he was evidently very hopeless about making good practice at so great a distance. The third drawback of the spherical bullet was the very much larger surface presented to the air in penetrating it than that of the elongated bullet. It is not too much to say that an entire revolution was effected by the adoption of the long bullet instead of the round one.

The notion of using bullets of an elongated shape was not new. Mr. Boucher, in his book published in 1860, says that as far back as the time of Henry V., in 1413, 'elongated shot of three and four calibres in length were fired from small cannon.' It is natural enough that something of the kind should have been tried, since the crossbow was made to discharge bolts and similar short, heavy projectiles, but it cannot be supposed that shot of this shape were a success, and their failure is proved by the fact that their use was not continued in smooth-bored guns. Robins, in the eighteenth century, had recommended an egg-shaped ball. In the year 1823 Captain Norton produced an elongated hollow projectile (figs. 6 and 7) on the expansion principle, making the hollow in the bullet contain the powder charge. In 1824 he submitted it in an improved form to the Select Committee on Firearms, but this Committee, having a most conservative objection to novelties, refused to have anything to do with it, and begged the question neatly by saying that 'a spherical ball was the only shape of projectile adapted for military purposes.' In 1841 M. Delvigne had included the use of a cylindro-conical bullet, an old idea of his, in a supplementary patent. Mr.

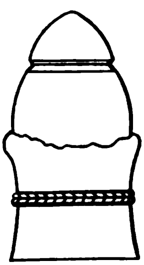


FIG. 6

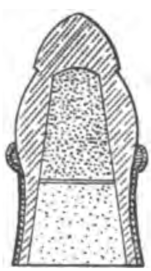


FIG. 7

Chapman, in 1848, says that in America, while the use of a round bullet was general, a round-ended 'picket' bullet (fig. 8) was occasionally used before the introduction of the pointed bullet with a flat base, known as a 'flat-ended picket.' The 'picket' bullet was evidently a 'peaked' bullet, as distinguished from a round one; the writer knows a field in the Midlands called locally the 'pickéd-piece,' because it runs into a sharp point. The type of the first flat-based conoidal bullets may be fairly judged, and also their great drawback, that they had little (if any) cylindrical part to centre them truly in the bore, from Mr. Chapman's illustrations of what was liable to happen with them, which we reproduce (figs. 9 and 10). Yet, so far, no bullet had been made with the

FIG. 8

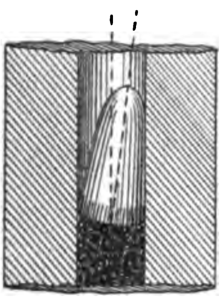


FIG. 9

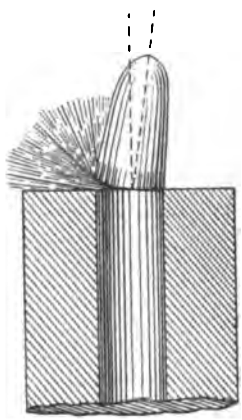


FIG. 10

distinguishing feature of modern projectiles—a flat or hollow base, with a cylindrical part next to it, then coming gradually to a point.

The long, pointed bullet, which is more accurately described as cylindro-conoidal, was a long time before it arrived at the perfection which it has in the present day. Delvigne found almost at once, when he had given the bullet a large hollow in the base to throw the centre of gravity forward, that the force of the powder behind it was enough to expand it into the grooves during its passage up the barrel. How far this was properly and effectually accomplished naturally depended upon several factors. The rapidity of ignition of the powder, the degree of softness of the bullet, the depth of the grooving, all bore their share in the result. In the days of which we are speaking, one of the greatest difficulties was to obtain powder of even make and of proper power. The deficiencies of the powder had formed one of the great difficulties of the early investigators, and it was not until a date later than that we are now speaking of that the manufacture of black powder was brought to the perfection it afterwards attained in the hands of Messrs. Curtis & Harvey and other makers.

It would seem that the first really successful application of the long bullet to the rifle was made by Captain Minié, of the Chasseurs d'Orléans, the Rifle Brigade of France. His name marks an epoch in the history of rifle developement. His first bullet was like Delvigne's, with a solid, flat base, and an ogival head (fig. 11). The form of this bullet had been almost precisely anticipated by Colonel Davidson, who used it in India in 1832. Similar bullets of his design are said also to have been used by the Edinburgh Rifle Club about 1840 (fig. 12). Minié's bullet was expanded in the ordinary way by using the Thouvenin rifle with the steel pillar. About the same time various improvements were made in the manufacture of the barrel. The long, pointed bullet required a ramrod with a countersunk end of the same shape as the point of the bullet, in order that the violent ramming of it should not disfigure the point (fig. 5). In 1849 Minié introduced the use of a hollow-based pointed bullet, with an iron cup in the base (fig. 13), with a flat-breeched rifle having no device for expanding the bullet by ramming it, and this is the first rifle in which the principle

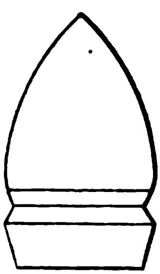


FIG. 11

FIG. 12

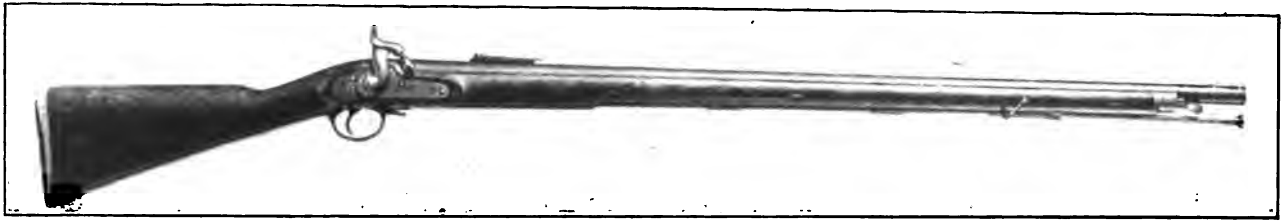


FIG. 1. ENGLISH MINIÉ RIFLE, 1850

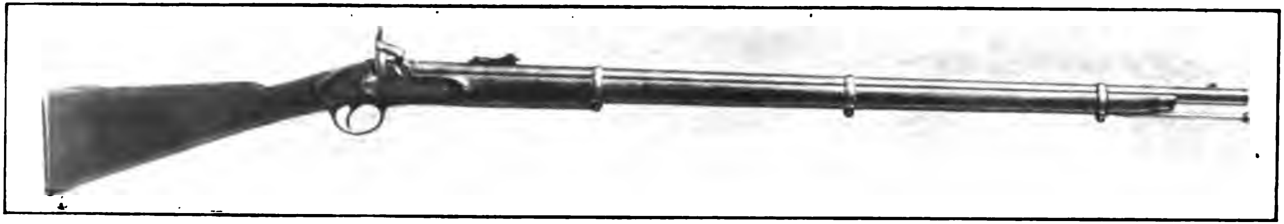


FIG. 2. ENFIELD RIFLE, 1852

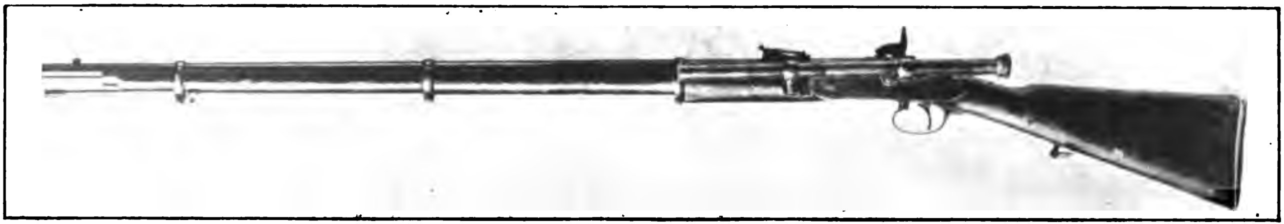


FIG. 3. WHITWORTH RIFLE, FITTED WITH DAVIDSON TELESCOPE, ABOUT 1861

since carried to such great perfection really appears in its simplicity.

The Minié rifle had a great success, and was adopted by France, Belgium, and, in 1850–1, by the British Government under the name of the new 'Regulation Minié Musquet.' The original English version of the Minié bullet as used in this arm seems to show a great want of perception on the part of those responsible for it. The bullet was made of a conoidal shape, with practically no cylindrical part to it whatever; and there was therefore nothing to ensure that it should travel up the barrel with its point in the middle line. It was not long before this projectile was put aside in favour of a better imitation of the Minié bullet, with a hollow base, and the little iron cup which was supposed to assist expansion by being driven up into the hollow as ignition took place.

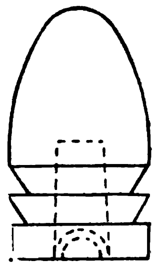


FIG. 13

It is to be observed that the Minié system, effective as it proved in its day, was far from perfect. The expansion of the bullet was not at all instantaneous on the ignition of the charge. So at least says Mr. Boucher, who in his book, 'The Volunteer Rifleman and the Rifle,' the first edition of which was published in 1853, quotes experiments of his own to prove that the bullet was driven a considerable way up the barrel before it took the impressions of the grooves properly. He further showed that the successful expansion of the bullet was not really dependent upon the iron cup, and maintained what had never been previously understood, that it was effected by the powder almost independently of the shape of the base of the bullet. 'It matters not,' he said, 'what the shape of the leaden projectile may be, if elongated, for all will expand, from the simple cylindrical solid plug to the most elaborate hollow conoidal bullet, and the expansion will be more or less, according as the bullets are longer or shorter.'

The English form of the Minié musket (Plate VI, fig. 1) had four grooves and a spiral inclination of one turn in 6 feet 6 inches. It was not at all a handy rifle; its calibre was 14-bore ('702 inch); it fired a heavy bullet of 680 grains, and was the first of our military weapons to be sighted to 1,000 yards. It was at once evident that the difficulties in loading caused by the fouling were largely overcome in this rifle, because the bullet was sufficiently expanded into the grooves for the fouling of each shot to be moderately well removed by the following one. It is surprising at the present day to see how enthusiastic men of fifty years ago could be over the merits of a weapon such as the Minié, clumsy and inaccurate as it seems to us. For a time some of the percussion muskets had grooves put to them, and were arranged to fire a bullet of 825 grains made on Minié's principle, their bore being larger than that of the Minié musket proper. This was a mere makeshift, although it was not without its use in the early part of the Crimean War.

The importance of arming troops with the best attainable rifle had before now been understood, and in 1852 careful trials were made of a rifled musket, which had been produced in the official factory at Enfield, and rifles made by the best gunmakers. Lancaster, Wilkinson, and Purdey were the most successful among those whose rifles competed against the Enfield.

It will be worth while to mention a little more in detail some of the points shown by these rifles. The Lancaster weapon, which had an increasing twist, was rifled on the oval bore principle of two grooves rounded off into the general line of the bore (fig. 14), which had been described by Colonel Beaufoy in the early years of the century, and had been applied to the musket by the Brunswick Captain Berner in 1835. The Wilkinson rifle had five grooves, with a regular twist of one turn in 6 feet 6 inches. The Purdey was a four-grooved rifle, with an increasing twist, commencing at one turn in 6 feet, and ending at one turn in 4 feet 9 inches.

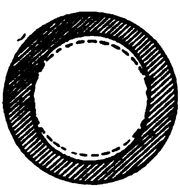


FIG. 14

The Enfield had three grooves, with a regular twist of one turn in 6 feet 6 inches. All these rifles had expanding bullets; the Wilkinson and Enfield had solid bases, the Lancaster bullet was hollow with a plug to fit it, and the Purdey fired a Minié bullet with iron cup. The Purdey was of ·650 bore, the Lancaster and Wilkinson ·540 and ·530 respectively, and the Enfield ·577. The general dimensions of the rifles were similar, the barrels being 39 inches long, and the weight of the rifles varied from 9 lbs. 1½ oz. to 9 lbs. 9 oz. In such company the Brunswick rifle was quite outclassed, as has already been mentioned.

At this time great stress was laid upon the method which had been devised by Captain Tamisier of making the bullet with a number of grooves round the cylindrical part near the base, which was supposed to offer a much increased resistance if the flight of the bullet became at all eccentric, and to steady it and keep it pointing truly in the line of flight. Fig. 15 shows a long bullet almost entirely covered with these specially shaped cannelures. We have since learnt that a bullet having proper gyroscopic stability stands in need of no such aid. Another invention of his, that of making the grooves, or the whole barrel, of greater depth at the breech than at the muzzle, was also a feature of some of the competing rifles. Neither of these principles has been proved to be sound, although the latter was retained in as recent an arm as the Martini-Henry.

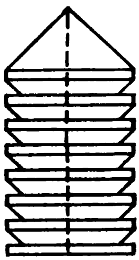


FIG. 15

On the whole result of the trial it was found that the Lancaster and Wilkinson rifles had a slight advantage in rapidity of loading, while the Wilkinson had rather the better trajectory. The Enfield rifle (Plate VI, fig. 2) was preferred by the Committée, and became the arm of the British army. This was for its period an excellent weapon, and stood for many years from 1852, through the change from muzzle-loader to breech-loader, until ousted by the Martini-Henry rifle with its smaller calibre, better disposition of weight in the bullet, and higher velocity.

About the same time Colonel (afterwards General) Jacob was devoting much attention in India to the rifle question. He was a remarkable man, who spent all his adult life in India. Distinguished as a mathematician, a scientific man, a mechanic, he was equally a noted artilleryman, engineer, sportsman, and soldier. For twenty-five years previous to

1854 he was carrying on experiments with rifled firearms. He was anxious to find a better method of rifling than that of the Brunswick rifle, and produced a four-grooved rifle, with a spherical ball with two bands cast upon it, which fitted the grooves easily. The East India Company refused to adopt this rifle in 1846, maintaining that the Brunswick rifle, being good enough for the Royal army, was good enough for their service. General Jacob's further experiments led him to abandon the round ball in favour of a conical ball almost without a cylindrical part, and with four projections on it to fit the grooving of the rifle. The form of Minié's bullet which he tried against this seems to have been a very rough imitation of the original, and not to have given anything like a satisfactory result. He presently found that he

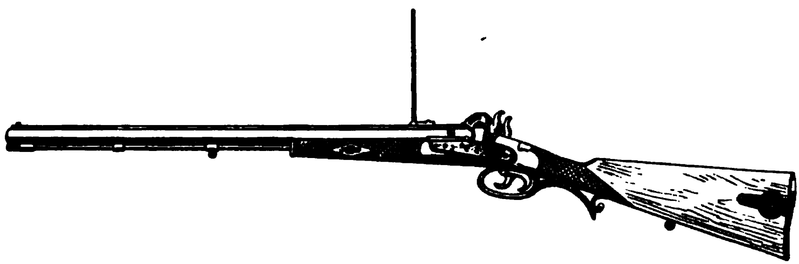


FIG. 16

could improve upon his conical or 'picket' bullet by giving it a long cylindrical part. He set up a range at Jacobabad, in Upper Scinde, which enabled him to shoot at every distance up to 2,000 yards, his butts being thick mud walls with bull's-eyes painted on them. He spared neither expense nor trouble in carrying out his experiments. Knowing well what was required for a military arm, he was working to try to bring to perfection an easy loading and effective rifle to take the place of the musket and the older pattern of rifle. His work seems to have been quite independent of influence from the French school of experiments, and he succeeded in producing a very effective weapon (fig. 16). Its calibre was 24, that is, ·579 inch, similar to that of the Enfield rifle; it was rifled with four grooves, and had what was then the very rapid twist of one turn in 3 feet. The bullet was a long one, with an ogival head, and four ribs cast upon the cylindrical part, which fitted the grooves of the barrel (figs. 17 and 18). He succeeded in obtaining considerable accuracy at 1,000 yards, and could even make something like practice at 2,000 yards, though using rather a small charge. General Jacob, making his bullet hollow, and to contain an explosive charge, succeeded in producing a very effective rifle shell, but the chief objection to his method seems to have been that the ammunition required great accuracy of manufacture, and was somewhat complicated to produce. At a time when it was doubted whether the rifle might not prove too formidable for artillery he foresaw the practicability and the advantages of using rifled artillery. It is to be feared that his work brought him little but disappointment, an experience common enough with those who have contributed to the advancement of firearms.

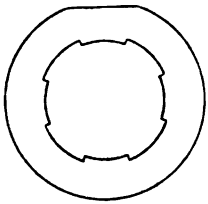


FIG. 17

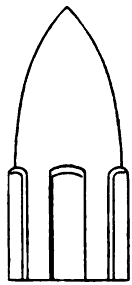


FIG. 18

The Enfield rifle held its ground for many years, and

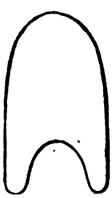


FIG. 19

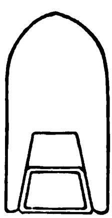


FIG. 20

FIG. 21

various alterations were made at different times in the bullet used. The Pritchett bullet of 1853 had a hollow base with no plug or cup (fig. 19). A hollow of a different shape was afterwards used, with a taper plug of boxwood or clay to help in sealing the bore (fig. 20). Mr. Metford invented, in 1856, an explosive shell (shown enlarged in fig. 21), which was adopted by the Government in 1863, after trials in which it proved superior to General Jacob's shell and one produced by Colonel Boxer. The charge of the Metford shell, which had a hollow nose, consisted of flour of sulphur and chlorate of potash in equal bulk, well mixed, and was protected by an airtight plug. This makes a very effective charge if the hollow be of a fair size. In 1869 this shell was declared obsolete in consequence of the Convention of St. Petersburg in the previous year, which had pronounced against the use of explosive projectiles weighing less than 100 grammes (about 14 oz.) in civilised warfare.

The Enfield rifle, which had been used during the latter part of the Crimean War in substitution for the Minié rifled musket first issued, remained the general weapon of the infantry until the introduction of breechloaders, in the year 1867. A short rifle of similar pattern was the arm of the Rifle Regiments, and a carbine of the artillery and cavalry. The Royal Engineers, then the Corps of Sappers and Miners, had been armed in 1855 with the Lancaster rifle of elliptical bore already alluded to. In 1858 the Navy was supplied with a short rifle of similar bore to the Enfield, five-grooved, with a spiral of one turn in 4 feet; this rifle was found to shoot better than the Enfield rifle pattern 1853, and the Rifle Regiments were armed with it.

The method of manufacturing all the parts of the rifle and lock to very accurate gauges so that they were interchangeable was adopted in 1860, and is now one of the features of all manufactures of military rifles on a large scale.

Sir Joseph Whitworth's well-known experiments with small arms for the Government were begun in 1854, and may be said to mark an epoch in rifle progress, not really so much because they introduced any original step of progress as because they dealt authoritatively with several points still in dispute. One great work which they effected was this, that they led to the general perception of the importance of extremely accurate workmanship and measurements in the manufacture of firearms. Walker, in 1865, says that at that time the best Birmingham gunsmiths had never reached a higher standard of exactitude in the size of the calibre than the 350th of an inch, and it was Sir Joseph's work which led to the appreciation of the importance of fractions of a thousandth. He had had no previous experience of small arms when he was asked by Lord Hardinge, who was then Commander-in-Chief of the Army, to consider the subject of rifling. After carrying out very extensive experiments at the public expense he recommended a rifle (Plate VI, fig. 3) of hexagonal bore (fig. 22) and of smaller calibre than the Enfield, ·450 inch, with a spiral of one turn in 20 inches, and a bullet of 530 grs., i.e. of similar weight to that used in the Enfield of ·577 bore. This alone gave a very great

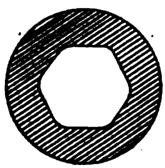


FIG. 22

FIG. 23

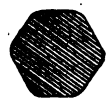


FIG. 24

advantage as against the old rifle, the proportions of weight of the bullets in effectiveness for flight and penetration being for the Enfield 227 and for the Whitworth 374, which gave the latter an advantage of just about 60 per cent. The Whitworth bullet (figs. 23 and 24) was $1\frac{3}{8}$ inch long and the Enfield bullet only $\frac{7}{8}$ inch.

The trials of 1857, according to Mr. Greener, showed that while the penetration of the Whitworth appeared to be greater than that of the Enfield, on referring to the material of which the bullets were made, and using Mr. Whitworth's harder metal in the Enfield rifle, and soft lead in the Whitworth, the penetration of the Enfield was not found to be inferior to that of the other rifle.

That some such diminution of the bore must have been shortly brought about in any case seems clear enough, as it was very obvious that much advantage would be gained by a considerable reduction in the calibre, and there were, no doubt, others besides Mr. Metford who had already arrived at that conclusion. Sir Joseph proved that it was necessary with a bullet of smaller section and greater length, such as he was using, to give a very much more rapid spiral than had previously approved itself. His spiral of one turn in 20 inches is, of course, not only actually but relatively far more rapid than that of the Enfield. The strict proportion between the calibres would have required for the ·450 bore a spiral of one turn in 61 inches. The spiral of the Enfield rifle was in itself inadequate, and the longer bullet needed a greater velocity in rotation to keep it point foremost.

It has been mentioned that the distinctive feature of the Whitworth rifle was the bore, which was hexagonal, the bullet being shaped so as to fit it exactly. This Whitworth rifle met with great success up to a certain point; it shot, as any well-made rifle of such a calibre was bound to do, with a very much lower angle than the Enfield, and its increased accuracy was almost in the nature of a revelation. The following table of comparative accuracy between the Enfield and the Whitworth is given by Sir Joseph Whitworth in his paper on 'Guns and Steel,' as the results of official experiments made in 1861:

Range in Yards	Enfield		Whitworth	
	Mean Radial Deviation	Mean Angle	Mean Radial Deviation	Mean Angle
	Inches	° ′	Inches	° ′
300	12·69	0 44·8	3·86	0 56·49
500	19·80	1 45·13	7·29	1 23·37
800	41·61	2 46·6	15·67	2 17·6
1,000	95·01	4 3·33	23·13	3 5·36
1,200	133·53	5 9·48	46·92	4 3·6

Sir Joseph applied his hexagonal rifling to cannon, but good as his results were, the polygonal form of rifling in both cannon and small arms was found after a time to possess certain disadvantages. The chief difficulty which had attended the muzzle-loading rifle, that of the accumulation of fouling on the surface of the bore, was not absent even with the improved powder now manufactured. Mr. Greener in his book, 'Gunnery in 1858,' mentions the following difficulty with the Whitworth rifle. He says:—'The deposit from the Government gunpowder became so tenacious in the hexagonal grooves that after a certain number of shots loading became a very difficult matter indeed, so much so, that Mr. Whitworth considerately provided a very superior description of gunpowder, with which the hexagonal rifle worked a little better.' A little book called 'Notes on Rifle Shooting,' by Captain Heaton, who was perhaps the most distinguished of rifle shots at the time when the Whitworth rifle was at the zenith of its fame, illustrates the same difficulty. He says that the Whitworth rifle used to foul after the twentieth to the twenty-fifth shot as ordinarily loaded, but that since using Whitworth's mechanical loading-rod or scraper, he could fire one hundred or more rounds without the foulness of the barrel interfering. Those who remember to have used this appliance will recollect that it was a scraper of the full size of the bore, and of a shape to fit it exactly, with which the barrel was scraped clean after each shot. Fouling that required removal by this very drastic process was naturally a grave disadvantage, and it was clear that the muzzle-loading rifle had not been put into its final shape.

CHAPTER III

NATIONAL RIFLE ASSOCIATION—THE QUEEN'S PRIZE—SOME WIMBLEDON HEROES—METFORD'S BULLET—2,000 YARDS' SHOOTING—METFORD'S SYSTEM OF GROOVING—HIS FIRST RIFLES—HIS MILITARY BREECH-LOADER—EARLY BREECHLOADERS—THEIR DIFFICULTIES—NEEDLE-GUN—SNIDER—MARTINI-HENRY—MARTINI-ENFIELD—THE ·303 RIFLE

In 1859–60 the new Volunteer movement had arisen as a reply to threatening talk of invasion from the other side of the Channel. This brought with it an immense interest in rifle shooting, and the man who had had the good fortune to obtain some practical acquaintance with the rifle by its use for stalking in Scotland or otherwise had every opportunity of distinguishing himself.

The Victoria Rifles had continued to exist as a Club since the beginning of the century, and there were a few amateur clubs in which the art of using the rifle was not altogether neglected. But it was the Volunteer movement of forty years ago, together with the assembling at Hythe of Volunteer officers from all parts of the country, who were practically initiated into all the mysteries of rifle shooting as it then existed, that led to a developement most important in the history of rifles in this country, the formation of the National Rifle Association, with which Lord Wemyss (at that time Lord Elcho) and Lord Spencer, both fortunately still among us, prominently identified themselves.

The first prize meeting of the Association was held on Wimbledon Common on July 2, 1860, after several months had been expended in bespeaking public interest, and arranging for the shooting and for the prizes. The scene at the opening of the meeting was a brilliant one: an immense crowd of spectators, among whom were a large number of Swiss riflemen, who had come over by invitation to show their skill to the British marksmen, was assembled. An address was presented by Mr. Sidney Herbert,[1] who was President of the Association, to the Queen and Prince Albert; and from under a tent set up at the firing point, where was a Whitworth rifle held in a fixed rest, the Queen, pulling the trigger with a silken cord, fired the first shot of the meeting. The target was an iron one, 400 yards away, with no visible bullseye; the blow of the bullet upon it was distinctly heard, and the result of the shot was at once announced from the butts: it had struck the target within an inch of the centre—a truly auspicious omen. Not only did the Queen thus personally open the meeting, but the prize given by her was, as it remained to the end of the nineteenth century, and still is under its new title of 'The King's Prize,' the 'blue ribbon' which carries with it the championship of the year for Volunteer marksmanship.

At the meeting of 1860 the long Enfield was, naturally, the weapon used in competing for the ordinary Volunteer prizes, but it had been decided that at ranges beyond 600 yards, at which the principal event of the meeting was to be decided, the very best military rifle which could be found should be supplied to the competitors. Of the wisdom, from the competitors' point of view, of this decision, which put into the hands of skilled shots a weapon to which they were not accustomed, and whose special peculiarities were quite strange to them, various opinions have been held. Yet it had this great advantage, that it gave rise during a series of years to an annual competition between gunmakers, to decide with whose rifle the final stage of the Queen's prize should be shot, while at the same time it impressed on the public mind how far from perfect was the Army weapon of the day. The Whitworth rifle conquered its competitors in the trial in 1860, and was accordingly used for the long range shooting for the Queen's prize, viz.: ten shots at 800, 900 and 1,000 yards. The winner of the Queen's prize was Mr. Edward Ross, then just going up to Trinity College, Cambridge.

Only 299 Volunteers competed at this first meeting, but there were prizes for all comers as well as for Volunteers; there were prizes for 'any' rifles, with and without magnify-

[1] Mr. Sidney Herbert, afterwards Lord Herbert of Lea, died August 1861.

ing sights and hair triggers, and there was a prize for breech-loaders, which was shot for at 800 and 1,000 yards. In this year 300, 500, and 600 yards were the distances in the first stage of the Queen's prize, and 800, 900, and 1,000 those at which the successful competitors in the first stage fired to decide the first place. The long ranges are at this day the same for the King's prize. In 1861 the 200 yards distance was substituted for 300 yards, and these six distances, at which this great prize was then and is now shot, have always been the chief, indeed, almost the exclusive ranges of the National Rifle Association competitions.

We are glad to be able to give, by the courtesy of Messrs. Graves, of Pall Mall, who hold the copyright of the engraving, an illustration (Plate VII) of the picture painted by Mr. Wells, R.A., for the Diploma Gallery in 1866. It is intended to represent a group of the most famous marksmen of the day firing at Wimbledon in the Wimbledon Cup competition. Unfortunately the artist has shown them as armed with the military rifle and firing with open sights, which must surely be incorrect. The rifleman lying down to fire is Captain Heaton; the one next him, standing up and adjusting his sights, is Mr. Edward Ross; Captain Pixley, the Queen's Prize winner of 1862, is standing behind, wearing the little round cap of the Victoria Rifles; next to him is Mr. Martin Smith; and then Sir Henry Halford. Captain Horatio Ross, father of Edward Ross, in the uniform of the London Scottish Volunteers, is looking on nearly facing the spectator. Above the group is the figure of Lord Elcho (now Lord Wemyss) mounted. The firers are sheltered from the wind by a canvas screen, known at the time as an Elcho screen, a device adopted for a few years at Wimbledon, probably in imitation of the sheltered firing points usual on the Continent.

The history of the National Rifle Association includes the history of the rifle from 1860 up to the present time, and in the competitions of the Association all improvements in the rifle which have stood the test of practical usage, and, indeed, a great many that have failed to do so, have made their appearance. One of the most important functions of the Association has been to provide an open field in which the

PLATE VII

SOME NOTED WIMBLEDON MARKSMEN, 1866

inventions and improvements made by private individuals may be impartially tested. In 1860 a rifle by Ingram, of Glasgow, with ratchet-shaped grooving, appeared in the prize-list, followed by the Henry rifle and others in 1861. The Henry rifling (fig. 25) was little else than a modification of the Whitworth rifle, but at the angles of the hexagon were left projections which brought the barrel more nearly to a shape with which a cylindrical bullet could effectively be used. The success of the Whitworth rifle brought into fashion mechanically fitting projectiles, such as an octagonal one, made by Westley Richards (the rifling of this is shown in fig. 26), but nothing original seems to have been produced. In 1862 the preliminary trial of rifles again showed the Whitworth rifle to be the best, though Mr. J. Rigby put into competition a rifle with ratchet grooving, firing a cylindrical bullet. In 1864 he again competed, but with a rifle on a different principle, firing a mechanically fitting bullet of hardened lead. In the usual trial held by the National Rifle Association at 1,000 yards from the machine rest his rifle made a figure of merit equal to that made by the Whitworth rifle, 1·83 feet; and at a subsequent trial in the autumn it proved itself the better arm, and was adopted for the second stage of the Queen's prize in 1865. The shooting that year for the Queen's prize was better than any that had hitherto been obtained, but the Whitworth was still the most prominent weapon in the class for 'any' rifles.

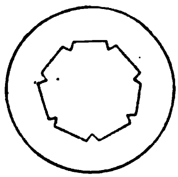


FIG. 25

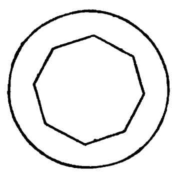


FIG. 26

Meanwhile, just as it seemed that the mechanically fitting bullet was carrying all before it, the application of wise and careful experience began to effect a fresh revolution. Mr. W. E. Metford, a civil engineer, whom Mr. Teasdale Buckell calls 'the father of modern rifle-boring,' had long been interested in all matters connected with the rifle. As early as 1852 he had carried on long-range experiments at the distance of 1,200 yards. He had suggested to Mr. Pritchett the construction of the Pritchett bullet adopted for the Enfield rifle by the Small Arms Committee in 1853, an invention which had marked a great improvement in the shooting of the service arm. As we have already mentioned, he had devised an explosive bullet for the Enfield rifle, which met with considerable success; this was a bullet of the same weight as that generally used, but it had a cylindrical hollow in the fore part. He found that his explosive shell was decidedly more accurate in its flight than the ordinary Enfield bullet, and this led him to adopt for his own use a bullet of similar form, but without the explosive charge. It appeared, in fact, that the removal of part of the lead from the centre to the circumference, which was the effect of leaving a hollow in the fore part of the bullet without diminishing the weight, gave greater stability in flight. Mr. Metford having won some important prizes at local meetings in 1862 and 1863, mainly owing to this improved bullet, made the secret of it—if the firing of a bullet exactly similar to the explosive bullet, but without the explosive charge, may be called a secret—public at the beginning of 1864, in connection with the proceedings of the Rifle Conference held in January of that year. Sir Joseph Whitworth, who patented a similar bullet early in the same year, when challenged by Mr. Metford, could not prove either originality or priority of invention. This bullet, which had a hollow base, was used subsequently as the service bullet, both in the Enfield as a muzzle-loader, and in the Snider, after its conversion to breech-loading.

In 1862 Mr. Metford became acquainted with the late Sir Henry Halford, who was in that year a prominent prize winner at the Wimbledon Meeting; this acquaintance ripened into an intimate friendship and partnership of thirty years in experimental work with the rifle. The greater portion of Mr. Metford's shooting was done on Sir Henry Halford's private range at Wistow, in Leicestershire.

In 1865 and 1866 the National Rifle Association held a special competition at 2,000 yards at Gravesend for muzzle-loading rifles weighing not more than 15 lbs. with telescopic sights. Mr. Metford specially made for this competition a rifle of about ·5-inch bore, which gave fair results, and was the only rifle entered for the competition in 1865, and the only rifle of two entered in 1866 which found the target.

Sir J. Whitworth did not enter a rifle in these competitions. The shooting made was moderate, 8 to 14 hits being made in 25 shots each by the different competitors using Mr. Metford's rifles. The target was 24 feet wide by 12 feet high in 1865, and 24 by 18 in 1866.

There was one feature common to all the rifles made up to this time in which the bullet was not mechanically fitted to a very deep grooving. This was that the grooves were made very substantially deep, and that it was thought necessary to have the bullet as soft as possible, in order that it might be driven into them without difficulty. The margin of size between the bullet and the bore was considerable, and the means used for expanding the bullet into the grooves were various. We have spoken of the hollow-based bullet and of Minié's iron cup, which was superseded for the Enfield rifle by tapered plugs, first of boxwood and then of clay. Even by such means it was difficult to ensure the proper sealing of the bore by the expanded bullet. Mr. Metford was the first to see that the very heavy friction set up by the soft lead was a great disadvantage, and that there was no necessity whatever for the use of deep grooving. He saw too that if the expansion of the bullet were kept within limits, by hardening the material of which it was made, it could still be expanded sufficiently to give it any desired spin without distortion and without unnecessary friction. No wonder that having found that grooves so shallow as to measure only one half of a thousandth of an inch in depth were capable of giving ample rotation to a bullet, if the surface of the barrel were clean, he declared that in the Whitworth rifle the rifling had as much hold upon the bullet as would suffice to spin a 6-lb. shot. He showed that with a bullet of proper shape, and slightly hollowed at the base, the expansion was effected by the blow of the powder upon the base of the bullet actually before the bullet had acquired any appreciable forward movement, and that a flat-based bullet was expanded quite satisfactorily. A civil engineer by profession—a profession which he had been forced to quit owing to the breakdown of his health when a railway engineer in India, from over-exertion in the troublous times of the Indian Mutiny—he appreciated all the scientific aspects of the various rifle problems, as well as the need for the most delicate measurements and exact work in dealing with them.

In 1865 Mr. Metford produced his first 'small bore' rifle, with five grooves equal in width to the lands between them, and only ·004 inch deep, and Sir Henry Halford at once made a sensation by winning with it the Cambridge Cup at the annual meeting of the Cambridge University Long Range Club, the competition consisting of 15 shots at 900, 1,000, and 1,100 yards on each of two consecutive days. The form of grooving in this rifle, which was of ·450-inch bore, is the very counterpart of that of our present service arm, the Lee-Enfield (fig. 27). This rifle was used by Sir Henry Halford in the Elcho Shield match in 1865, but did not take a high place in the competition. In 1866 Mr. Metford's rifles were very conspicuous in all long-range competitions. With them the difficulty caused by the fouling vanished. The shallow grooving was practically cleaned in the act of loading, and the bullet, in a thin paper jacket, swept out absolutely all residuum in its passage up the barrel, so that no accumulation of fouling was possible. From that time it was clear that the use of mechanically fitting bullets was doomed. Other rifle makers followed the new method, until by the year 1871 rifles on the old system had entirely disappeared.

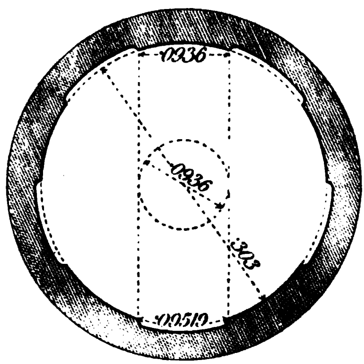


FIG. 27

The shallow grooves, the bullets hardened with tin or antimony, the rifle barrel made with an exactitude formerly unknown, but now, owing to improvements in gauges, tool-making, and steel within the reach of every gunmaker; soon achieved results in this country and in America which had never before been equalled. It was unfortunate that the War Office Committee, which adopted in 1868 the Henry barrel and rifling, with a compound cartridge case of rolled brass foil, and the Martini action, did not fully appreciate the importance of Mr. Metford's principles. His increasing spiral, it is true, did not justify the hopes which its scientific origin had raised, but the Henry barrel, with its deep-angled grooving, a veritable trap to hold the fouling of the powder and difficult to clean thoroughly, was infinitely behind the accuracy and simplicity of the Metford barrel.

The Committee which recommended the Martini-Henry in 1869 had not before it Mr. Metford's inventions, since, in his broken state of health, and with recollections of a not over-generous treatment by the authorities in connection with his old invention of the explosive bullet, he did not see his way to enter the gunmakers' competition which was held in connection with the new rifle. But having taken up in his own time the problem of producing an efficient military breech-loader, he produced within two or three years a rifle which soon made its mark. It was his invention of the hardened cylindrical bullet and the shallow grooving, as against the mechanically fitting polygonal bullet, which had brought the construction of breech-loading rifles and ammunition within easy possibility. The inconvenience in loading of having to turn the cartridge when made up with a polygonal bullet, so that the angles of the bullet came opposite to those of the rifling, was in itself a considerable drawback in muzzle-loading; in a breech-loader it made serious delay.

In 1871 Mr. Metford brought to Wimbledon two rifles and a limited supply of home-made ammunition, and with one of these rifles Sir Henry Halford won the Duke of Cambridge's prize for military breech-loaders, a single prize of 50*l.* decided in a final stage at 1,000 yards. The next year a Metford rifle again won the Duke of Cambridge's prize. For these breech-loaders Mr. Metford adopted the segmental form of groove, which leaves no corners to hold the fouling. This grooving is very similar to that described by Mr. Boucher many years before in his book, 'The Volunteer Rifleman and the Rifle,' except that Mr. Boucher left hardly any lands between the grooves; he recommended five grooves; Mr. Metford occasionally used five, but normally seven. A segmental grooving had also been tried in America in the year 1856 in the course of some official experiments. Mr. Metford, as we have seen, had used with great success another form of grooving for his muzzle-loading rifles. His adoption of the segmental grooving for the breech-loader, as helping materially to deal with the difficulty of fouling, was a very great element in the conspicuous success of his military rifle. We give a diagram (fig. 28) of the Metford grooving for the ·303 rifle.

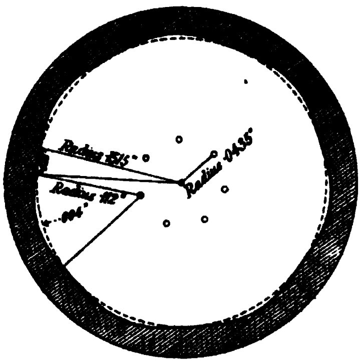


FIG. 28

From 1871 to 1877 his rifles continued to gain favour. Mr. Metford gave constant personal attention to the supervision of their manufacture, first by Gibbs, of Bristol, and then also by Westley Richards, in every detail of the arm and its ammunition. Then, for a long series of years, in fact, so long as military rifles of ·450 calibre and the like were in vogue, they had something like a monopoly of the long-range prizes for that class of arm at the meetings of the National Rifle Association. The Martini-Henry soon found its level as a weapon of very inferior accuracy, and before long disappeared altogether from the prize lists of the long-range competitions open to other breech-loaders.

Mr. Metford was in all things practical, and in all his inventions and improvements refused to be led aside from the path of simplicity and utility. His ammunition was fit for service in any climate, for he at once adopted a solid drawn brass case, nor would he have in the cartridge any lubricant beyond a couple of felt wads saturated with paraffin wax, and not liable to damage the powder by the melting of a greasy substance. The bullet was wrapped in a thin hard paper, which projected hardly at all from under the protection of the metal cartridge case. If cartridges of this kind, and they were really within the reach of the Small Arms Committee of that day, are compared with those of the Martini-Henry—extremely liable to deformation from a blow, with a plug of beeswax behind the bullet ready to melt and run into the powder if over-heated by the sun, and with paper round the bullet which the slightest rubbing would inevitably tear—it will be understood that the Committee which recommended the Martini-Henry rifle must have been unfortunate in its advisers.

The narration of Mr. Metford's work has carried us rather abruptly from the muzzle-loader to the breech-loader, but the transition was really a very gradual one. The principle of breech-loading is very nearly as old as the existence of fire-arms, and was applied both to cannon and to small arms in very early times. There is in the Tower of London a breech-loading arquebus of the time of Henry VIII., bearing the letters 'H. R.' and the date 1537; and there is no reason at all for thinking that breech-loading was a novelty at that time. One great inducement to adopt it for small arms firing bullets was that it obviated the need of ramming a tightly-fitting projectile down the whole length of the barrel. Robins, as late as 1742, having mentioned this material difficulty of loading, great when the bullet was wrapped in a greased patch, greater still when the naked bullet was forced down the bore, says:—'As both these methods of charging at the mouth take up a good deal of time, rifled barrels, which have been made in England (for I remember not to have seen it in any foreign piece) are contrived to be charged at the breech, where the piece is for this purpose made larger than in any other part. And the powder and bullet are put in through the side of the barrel by an opening, which, when the piece is loaded, is filled up with a screw. . . . And perhaps somewhat of this kind, though not in the manner now practised, would be of all others the most perfect method for the construction of these sorts of barrels.'

The form of breech-loader which is here alluded to seems to be similar to that known as the Ferguson carbine, used in the American War of Independence by British troops, and illustrated by Mr. W. W. Greener in his copious work on 'The Gun and its Development.' In this rifle the trigger guard formed part of a lever which could be moved laterally, and was pivoted at its front end, being attached there to a large vertical screw which was raised or lowered by turning the lever, and when lowered left an opening at the top of the breech through which the bullet and powder charge could be inserted. This rifle was the invention of Lieut.-Col. Patrick Ferguson,[1] 2nd Batt. 71st Highlanders, dating from before 1776; it was sighted from 100 to 500 yards, and with it he could fire six shots in a minute.

The earliest types of breech-loaders had for the most part a detachable chamber which dropped into a recess behind the breech, and was held in place by some sort of a wedge. The difficulty constantly experienced was that the material and workmanship did not admit of what would be called nowadays a complete obturation of the breech; the flame from the explosion always leaked out, and was apt to produce unpleasant if not dangerous consequences. Almost every imaginable device was tried at one time or another to produce a satisfactory breech-loader. The barrel was hinged, so as to open at the breech sideways, or downwards (as in the Lefaucheaux breech-loader of modern times); or some kind of hinged shoe was fitted which opened behind the barrel, and allowed a charge to be inserted. Many other methods were tried by the ingenious. But a more or less disastrous leakage of flame had until this period seemed inevitable. Another trouble with the early breech-loaders was that the working of the mechanism was apt to be hampered by the fouling deposited in it. It was little wonder that as the necessity of having powerful weapons increased, the breech-loading principle appeared to offer more and more difficulties. We are well accustomed to it now, both in small and large weapons, and it is curious, looking back even to the middle of the nineteenth century, to see how reasonable were the objections to the breech-loading principle as then carried out in sporting arms, and how great the prejudices against it. Even more recent is the change as regards artillery, but this is a question wholly outside our present limits. In 1858 Greener declared that "time and ingenuity spent in planning and constructing breech-loading

[1] This is the same Ferguson already mentioned on p. 24.

cannon will always end in disappointment and failure,' and again, that 'striving to produce perfect breech-loading cannon is like striving to square a circle.'

Some of the English cavalry were supplied with the Sharps American breech-loading carbine in 1857, and about the same time trial issues were made of Westley Richards', Terry's, and Green's systems. The Sharps rifle (fig. 29) had a falling block action, and was perhaps the best breech-loader of its day, but the usual trouble of the escape of gas at the breech was experienced with it. In Deane's 'Manual of Firearms' is given a list of twenty-four foreign breech-loading systems,

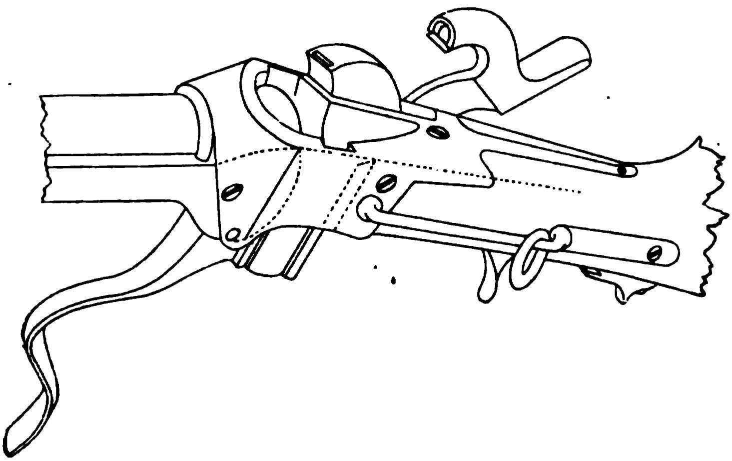


FIG. 29

from 1830 to 1854, of six American actions, and of nine English, from 1853 to 1858.

The most prominent among the early military breech-loaders was undoubtedly the Prussian needle-gun; this gun dates from 1839, and was officially adopted in 1848. The cartridge was made of a thin material and was self-consuming. It had a disc of fulminating composition placed in front of the powder charge behind the base of the bullet; on the trigger being pulled a long needle was driven forward, which penetrated the base of the cartridge and the powder charge, and as soon as it pricked the fulminating disc, exploded the charge. This system was open to various objections; the needles were constantly rusting and breaking, and the escape of flame from the breech became so bad that, according to Scoffern, in the Danish war of 1864 the rifles could in many cases not be fired from the shoulder because of the back-stroke of the escaping flame. This rifle had a bolt-action (fig. 30), and the opening and closing of the breech was a matter of great difficulty, so that it was thought by many that the needle gun must certainly be abandoned. But on the contrary the Prussian authorities added very largely to their supply, and they were justified by the result, for the rifle was used with great success in the Austrian War of 1866, and did its work well on the whole in the Franco-German

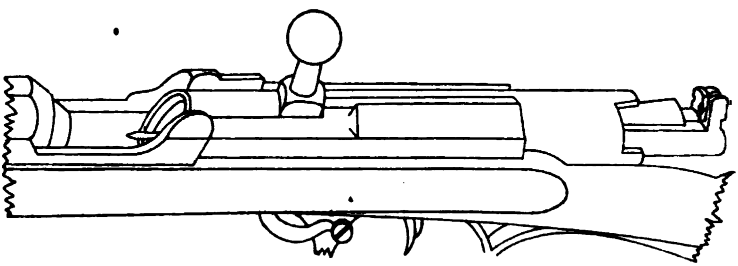


FIG. 30

War of 1870, although it was not equal in range to the French Chassepôt.

In June 1864 a Committee of officers was assembled to report on the expediency of introducing breech-loading arms for general adoption by the British army. Plans for the conversion of the muzzle-loading Enfield rifle into a breech-loader were asked for from the various gunmakers, and nearly fifty different methods of conversion were proposed, the large majority of which were found to be unsuitable. Eventually, after much labour, the Committee recommended the plan proposed by Mr. Jacob Snider, whose well-known breech arrangement consisted in fitting behind the barrel a hinged block, which could be raised and turned over laterally so that the cartridge could be inserted in front of it. Figs. 31 and 32 show the breech action closed and open. It had by this time become clear that there were great advantages to be gained by the use of a cartridge case of metal, although this plan had not yet been adopted by any of the foreign Powers, and the Chassepôt rifle adopted by France in 1866 had a self-consuming paper cartridge. The old and perpetual

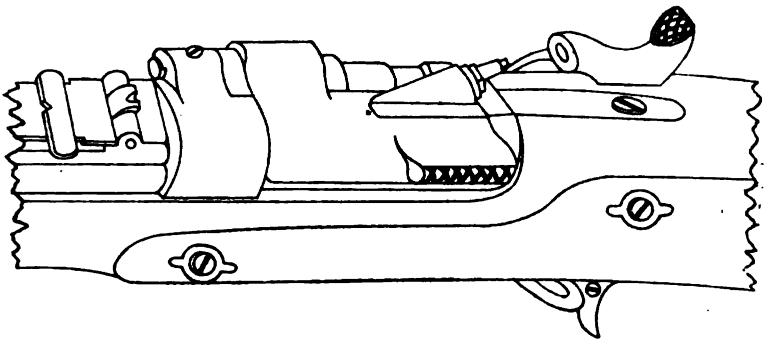


FIG. 31

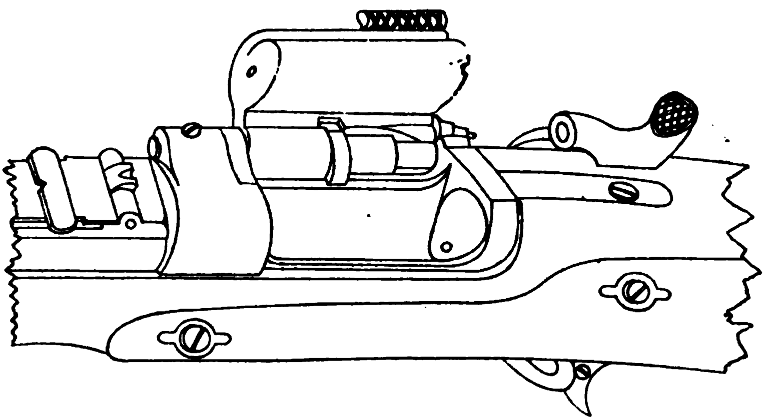


FIG. 32

difficulty of the escape of gas from the breech was found to be entirely obviated by the use of the metal cartridge case, as the explosion of the charge, expanding it tightly against the walls and base of the chamber, effectually sealed the breech against any backward escape of gas. The shooting of the converted rifle was at first not at all equal to the standard of its accuracy as a muzzle-loader, but Colonel Boxer's cartridge, adopted in 1867, remedied this difficulty. Fig. 33 shows the cartridge in its final form. Plate VIII, fig. 1, shows the complete rifle.

The war of 1866 between Prussia and Austria, in which the troops of the latter fought with a muzzle-loader against the needle-gun, proved to the world the great advantages of the breech-loader, and after that time the muzzle-loader was universally converted or superseded as a military arm in Europe and America. The conversion of the Enfield rifle to a breech-loader had put England for the moment ahead of other nations, but this was merely a stop-gap arrangement, and another Committee was appointed by the War Office in 1866 to consider the question of a new pattern of rifle for future manufacture. About 160 different arms, and 50 kinds of ammunition, were considered by them, but it was found that none of them attained the standard of accuracy laid down, one which could be reached by a reasonably good muzzle-loader. Various bores were tried, from ·577 to ·450, and it was clear that the question of the barrel and cartridge to be adopted could be separated from that of the method of closing the breech. In the end certain conditions for the size and bore of the barrel, and for the dimensions and charge of the cartridge, were laid down, and a limited number of gunmakers were invited to produce rifles conforming to these conditions, all to be fitted with one system of breech-action, the Henry, and to be tried against each other, and against the products of the Enfield and Woolwich

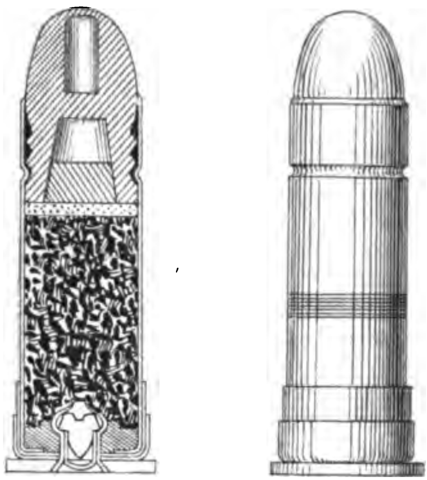


FIG. 33

PLATE VIII

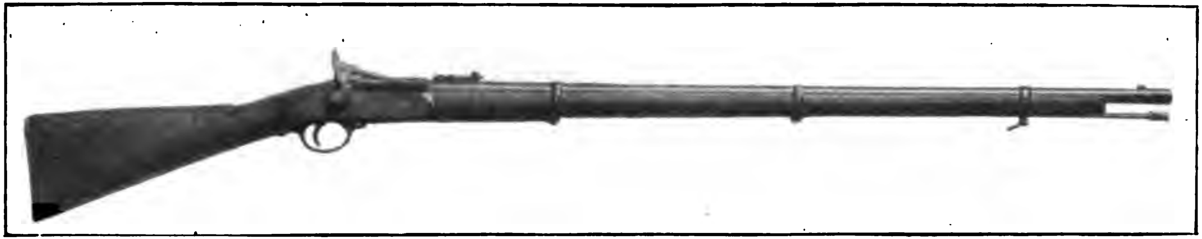


FIG. 1. SNIDER RIFLE, 1867

FIG. 2. MARTINI-HENRY RIFLE, 1871

factories. Messrs. Henry, Whitworth, Westley Richards, Lancaster, and Rigby competed; Mr. Metford, unfortunately, did not see his way to do so.

These rifles, and also the various breech actions which had been submitted, were carefully tried, and in February, 1869, the Committee recommended the breech mechanism with a hinged block produced by Mr. Martini, and the barrel of ·45 inch calibre submitted by Mr. Henry. The Henry rifling, which has already been described, had seven grooves, but its sharp re-entrant angles tended to accumulate fouling; the twist was right-handed, and of uniform pitch, the spiral making one turn in 22 inches. Martini-Henry rifles were issued for trial in November, 1869, and in March, 1870, the chamber and breech action were modified to allow of a cartridge of bottle shape, that is, with an enlarged powder-chamber behind the bullet, being adopted (fig. 34). In the spring of 1871 the arm was definitely approved for the Army (Plate VIII, fig. 2). Though good work was done with this rifle, it had one very weak point: the extraction was not powerful enough, as our soldiers afterwards found to their cost on some few occasions when fighting in Egyptian sands. This weakness of the action had been pointed out in vain at the time of its adoption. Though it would be perhaps going too far if we should adopt the description, 'a miserable malformation,' which has been applied to the Martini-Henry rifle, it certainly did not represent the best knowledge and invention of its time. An illustration

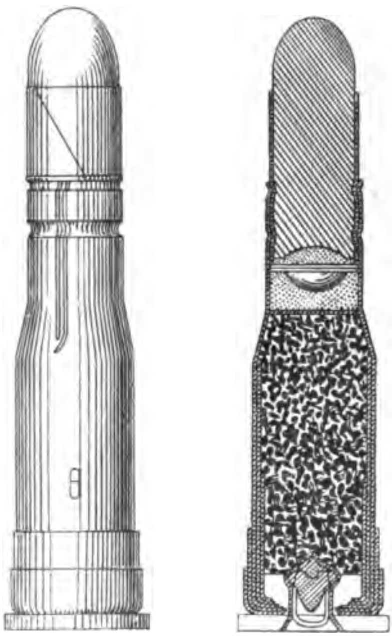


FIG. 34

is appended of the Martini action, shown in section at full cock (Plate IX).

Meanwhile other nations—Germany, Holland, Italy, and Russia—were adopting improved rifles with 'bolt' actions, on the simple principle of the door bolt, on which the action of the needle-gun was based, and which is at the present time used in nearly all modern military rifles. In the same year Spain adopted a rifle with the American Remington action, and between 1873 and 1881 all the rest of Europe had adopted rifles of about the same power, with calibres of ·430 to ·450.

The retention of the bore of ·450 inch as the general calibre of military rifles did not last very long. The question of changes was being considered in this country, and after some investigation of magazine rifles up to 1880, which led to no result, in 1883 a new Committee was appointed to consider the production of an improved Martini-Henry rifle, and report on the desirability of introducing a magazine rifle, and to recommend some pattern of magazine and action. As regards the first part of their reference, it was decided to recommend a calibre of ·402 inch and rifling of seven grooves shaped to the segment of a circle, of the pattern already described, which was used by Mr. Metford in his breech-loading rifles with such marked success.

This form of rifling, unrivalled as it had proved itself at Wimbledon for many years, was only adopted after exhaustive trial of other groovings, notably what is known as a ratchet grooving (fig. 35), which was very nearly being finally selected. In ratchet grooving, the groove, instead of being made symmetrical, is deeper at one side than at the other. The object of making it so has usually been to overcome any tendency of the bullet to strip by giving it a greater bearing surface on the side of the groove which takes the pressure of twisting it and diverting its surface from motion in a straight line as it begins to move up the barrel. Ratchet grooving, called by the French *rayons à virgule*, has been tried by many makers, and specimens of it may be found in ancient collections. But it

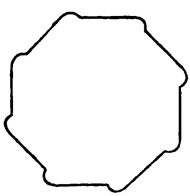
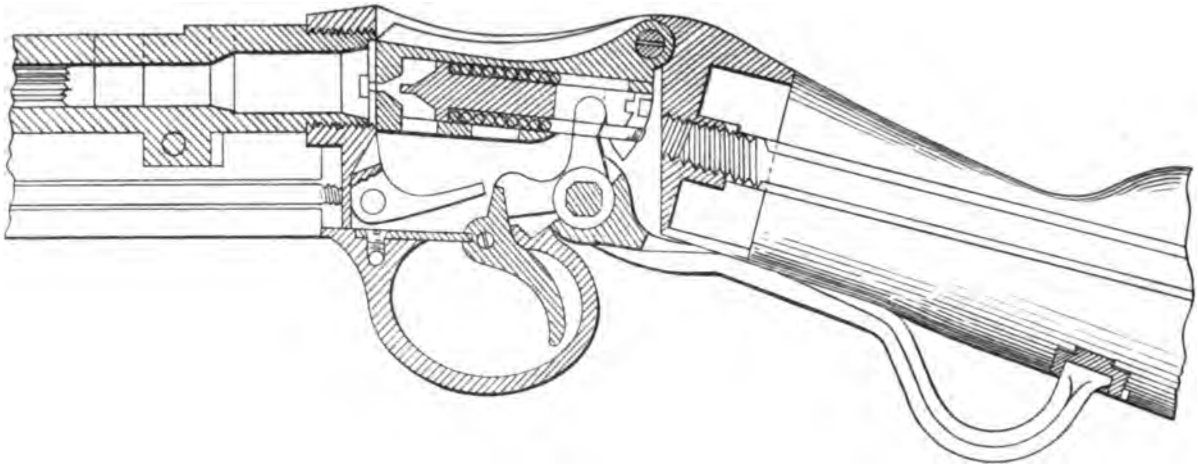


FIG. 35

PLATE IX



ACTION OF MARTINI-HENRY RIFLE (COCKED)

has, in fact, been found that to make the grooves deeper on one side than on the other leads to no useful result. The ratchet grooving proposed for the Martini-Enfield was much criticised because the ratchet was turned the reverse way from that which was usual, and the side of the grooves which had to take the resistance of the bullet and give it its spiral motion was the sloping and not the steep side. This was no accident, although it is difficult to appreciate the intention of such an arrangement. The minds of those who knew how great was the superiority of the Metford system over any other before the public were much relieved at the final decision of the Committee.

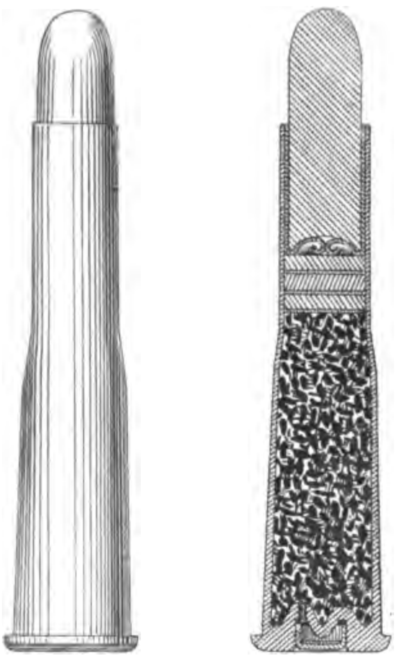


FIG. 36

The rifle known as the Martini-Enfield was evolved as the result of the Committee's work. A limited number were made and issued for trial in 1886. This rifle had a great advantage in velocity and flatness of trajectory over the Martini-Henry, and in many ways marked a distinct stage of advance, although it was never adopted as the arm of our troops. The Martini action was retained, the lever being lengthened to give greater power in extraction, but it was almost at once evident that the requirements of the day had not been fully met. In view especially of Continental developements the rifle was withdrawn after a considerable number had been made, but before it had been issued to the troops. Fig. 36 shows the cartridge for the machine gun of this calibre.

Just at this time, in spite of the reluctance of the authorities to depart from the single loader to which they were accustomed, the necessity for a magazine rifle was asserting itself with overwhelming force, and another developement almost as important, with which we will first deal, was coming to the front.

Experiments on the Continent had for some years been in progress as to the advisability of a further considerable reduction of the calibre. Major Rubin, the head of the Swiss Ammunition Factory at Thun, had in 1883 submitted a rifle of 7·5 mm. calibre (·295 inch) to the military authorities there. Two principal difficulties had been found in the production of a rifle of very high velocity and small calibre. One was that the bulk of powder necessary to give a high velocity made a very clumsy cartridge for a rifle of small calibre; and the other that the pressures and friction on the leaden bullet in the barrel were so severe as to produce distortion and melting, and consequently very unreliable shooting. The first difficulty Major Rubin overcame by using a charge of black powder pressed into the form of a cylindrical pellet, and perforated longitudinally by a small hole to help to carry forward the flame from the cap. This pellet of black powder was dropped into the cartridge case, to which the bullet was then fitted by the introduction of a small brass ring, which made up the difference in size between the interior of the cartridge and the exterior of the bullet, and was prevented from being driven forward into the barrel by a shoulder in front of the chamber against which it abutted. Afterwards the same result was attained by forming, on the cartridge case, after the powder had been put into it, a neck of the size of the bullet. The latter system is now generally used, as the loose ring of Major Rubin's original cartridge was found occasionally to become detached from the shell and to give trouble by remaining in the barrel. The other point of difficulty which we have mentioned, that of the strains upon the bullet, was boldly overcome by Major Rubin and by Hebler, who made the bullets with a leaden core fitted into an outer envelope of copper. This casing of the bullet in a hardened skin removed all the defects experienced with the soft lead bullet. By these means a new type of rifle suitable for military purposes and in many respects superior to all previous weapons was produced.

As is the case with any startling innovation, this sudden reduction of bore to something far less than had been generally used, even for shooting rooks, in this country, was not easily accepted. Even the members of the Committee which finally recommended it had almost one by one to be converted to a belief in it as a practical developement. The writer believes that it was the late Colonel Slade, then Commandant at Hythe, who pressed it upon the attention of the Committee, seeing the immense military advantage, especially for a magazine rifle, of a cartridge of much reduced bulk and weight.

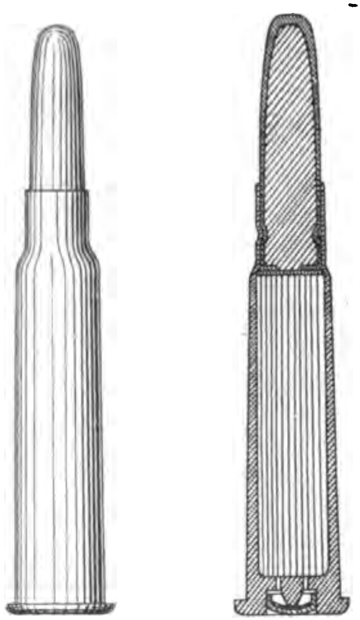


FIG. 37

Not only could something approaching double the quantity of ammunition be carried in the same space and for the same weight as formerly, but the storage of a supply of cartridges in the magazine was rendered possible without the clumsiness and weight which made so much difficulty in applying the magazine to the older rifles. The whole cartridge of the ·303 rifle (fig. 37) weighs materially less than the bullet of the Martini-Henry, and the space required by the ammunition in storage is proportionately reduced. Some disadvantages, on the other hand, attend the smaller bore in comparison with the larger. The ammunition is necessarily more expensive, partly because of the use of smokeless powder, partly because a compound bullet, especially with a sheath containing a metal so expensive as nickel, is necessarily costly to make. The wear and tear upon the barrel is vastly greater, and consequently the expense of repairs and renewals of the arm is substantially heavier. The reduced diameter of the bullet in combination with the hardness and power of resistance to deformation given by the metal sheath as ordinarily manufactured diminishes its disabling power as compared with that of the older patterns, since the bullet, instead of becoming distorted and opened by the resistance it meets with, and so expending the whole of its force in tearing and damaging whatever is in its way, perforates the tissues and material, which it penetrates with a clean hole. The flat trajectory, however, has a very great military value. It is the balance between these advantages and disadvantages that must decide to what point the reduction of calibre in military arms can profitably be carried.

CHAPTER IV

DEVICES FOR RAPID FIRE—THE REVOLVER PRINCIPLE—REPEATING RIFLES—MAGAZINES—CLIP AND CHARGER LOADING—SOME FOREIGN SYSTEMS—THE LEE-METFORD AND LEE-ENFIELD—EROSION—SMOKELESS POWDERS—ACCURACY—VARIOUS BULLETS—BOLT ACTIONS—MILITARY RIFLES DESCRIBED—AMMUNITION SUPPLY—FIRE CONTROL—VOLLEY-FIRING.

MEANWHILE Continental developements forced the abandonment of the single-loading principle. The rapidity of fire obtained from improved hammerless breech-loaders was, it is true, considerable. These naturally fell into two classes. With rifles having falling-block actions, such as the Martini-Henry, the cartridge required to be pushed forward into the chamber before the breech could be closed; with the bolt action, the cartridge had only to be dropped into the trough in front of the bolt, and the closing of the bolt carried it forward into the chamber. The difference in rapidity of loading between the two classes was not very material. But when it was found that there could be successfully applied to the rifle mechanism which enabled a store of cartridges to be placed in it, and fired in succession without being individually handled, the next great stride in the developement of firearms was in sight, and the bolt action, which was especially convenient for use with the magazine, at once rose into prominence.

The best known means of obtaining rapid firing in small arms is by mechanism on the principle of the revolver. This has now been in vogue for very many years, and is a far older invention than the time of Colonel Colt. Revolving arms of the sixteenth century exist, and many-barrelled weapons were made very early. The old muzzle-loading revolving pistol known as the 'pepper-pot,' with its full-length barrels all revolving on a pivot, was effective in its degree, and with the invention of the breechloader it was possible to apply the same principle in a much more compact form. Weapons on the principle of the revolver are differentiated from magazine arms by the fact that they are in reality many-chambered weapons; that is to say, although there is only one barrel, a certain number of cartridges can be loaded into a cylinder containing chambers for them each capable of withstanding the explosion. Each chamber in turn is brought into line directly behind the barrel before it is fired, and the bullet is passed into and through the barrel by the force of the explosion, jumping over the small interval between the chamber and the barrel. This is a very different principle from that of the magazine rifle, in which the mechanism is directed to giving an extremely rapid supply of cartridges, which are successively placed in the same chamber and fired. The weak point of the revolver principle, the break between the chambers and the barrel, has always prevented it from being applied with real success to rifles. So long as the charge is small, the thickness and weight of the chambers in the revolving cylinder are only moderate, but the actual mass of metal which would be required in a cylinder containing long cartridges giving a high pressure would in itself have been enough to prevent the successful application of the principle to rifles of any power.

Systems of loading which are merely arranged for the rapid mechanical delivery of cartridges into the barrel on the mechanism being actuated by the hand, may be divided into two classes: repeating arms, among which by an arbitrary use of the term we may include only those systems in which the cartridges lie nose to base in a tube under the barrel, or in the stock of the rifle; and magazine arms, in which the store of cartridges lies compactly in a box or other receptacle of no greater length than is required for a single cartridge. It was in America that the repeating principle was first brought into use. The Spencer rifle (fig. 38), which was patented in 1860, had cartridges placed in a tube in the stock, and brought forward by a spring. A lever forming the trigger-guard and a prolongation of it when pushed downwards and forwards actuated the mechanism. In the Henry rifle of the same period the cartridge lay in a long tube under the barrel; and the Winchester rifle, which followed it, had a similar arrangement. This rifle has had for many years a great vogue; it dates from 1867, and was the arm used by Turkey in the Russo-Turkish War of 1877-8. The enormous power of fire then developed from these rifles showed the world that it was a great advantage to have at command an extremely rapid delivery of fire, and from that time the attention of all Governments began to be turned towards devices for rapid loading. The Russians had used in the same war an apparatus called the Krnka quick-loader, a magazine attached to the rifle and holding the cartridges in a convenient position to be rapidly loaded into the rifle by

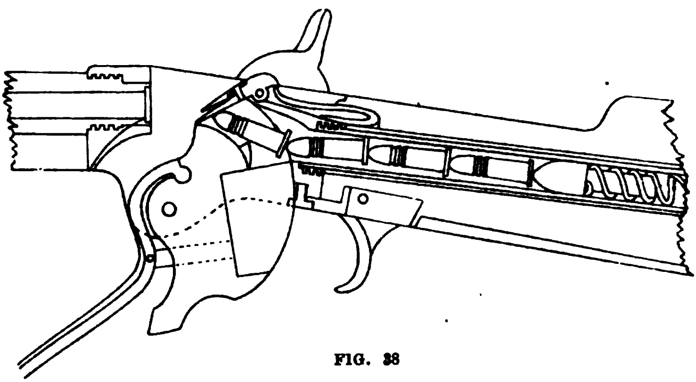
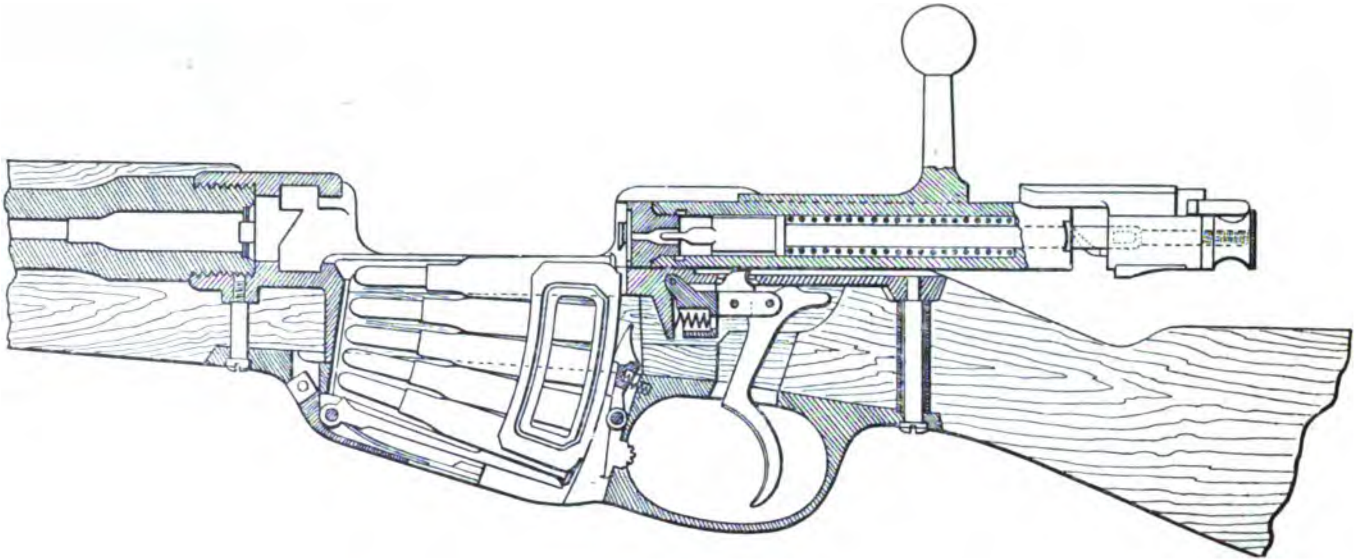


FIG. 38

the fingers. Still, this method was only a makeshift, and did not give rapidity enough to hold its own.

The repeating principle, though it still exists in the military arms of two or three nations, and notably of France, has not on the whole commended itself in these latter days. Accidents have been known to occur from the point of the bullet of a cartridge in the tube striking, in the jerk made by the recoil, the cap of the cartridge in front of it and exploding it. The balance of the rifle is altered with every cartridge removed from the magazine or put into it. There is no option but to put the cartridges one by one into the tube; more than one cannot be inserted by a single motion. From such drawbacks as these the magazine system is normally free. There are many varieties of it, but all of them are most conveniently used with the bolt action, which in one or another

PLATE X



MANNLICHER ACTION. DUTCH MODEL, 1895

of its forms may be said to have been universally adopted for modern military arms. The withdrawal of the bolt extracts and ejects the case of the fired cartridge, and as it is pushed forward it carries with it a fresh cartridge, which has been automatically brought into position to engage with it, having been made by the action of a spring to protrude a little while the bolt was withdrawn. In this way the supply may be continued until the magazine is empty, when it is refilled either by cartridges put into it singly or by several inserted at the same time. There are three methods by which a number are inserted simultaneously. The first is called clip-loading, and is exemplified in the Mannlicher action (Plate X). In this the cartridges are held together by a metal clip, which is placed in the magazine with them, and falls out through an opening in the bottom when the last cartridge is loaded into the chamber. Next follows the system of charger-loading, in which the cartridges are held together by a kind of clip which enables them to be swept into the magazine with one motion of the thumb; the clip being left behind is then thrown away. The Mauser action (Plate XI) is the best known example of this. This system allows the cartridges to be packed in the magazine in a double column, so that it will contain a larger number in proportion to its depth. Fig. 39 shows the packing of the cartridges in the Mauser, pattern 1895. The third system is to supply loose cartridges into the magazine, several being dropped into it with one motion of the hand. Similarly the magazine may be, as in the Lee-Metford, a box lying underneath the action, which can be detached and loaded or emptied apart from the rifle. It may be little more than a vacant space into which a clipful of cartridges can be placed, and which allows the small metal clip which holds them together to fall out when the last one has been fired. It may be, as in the Mauser, a box into which the cartridges can be swept out of the charger which contained them. It may consist, as in some of the

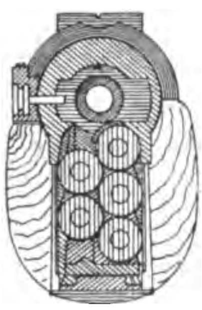
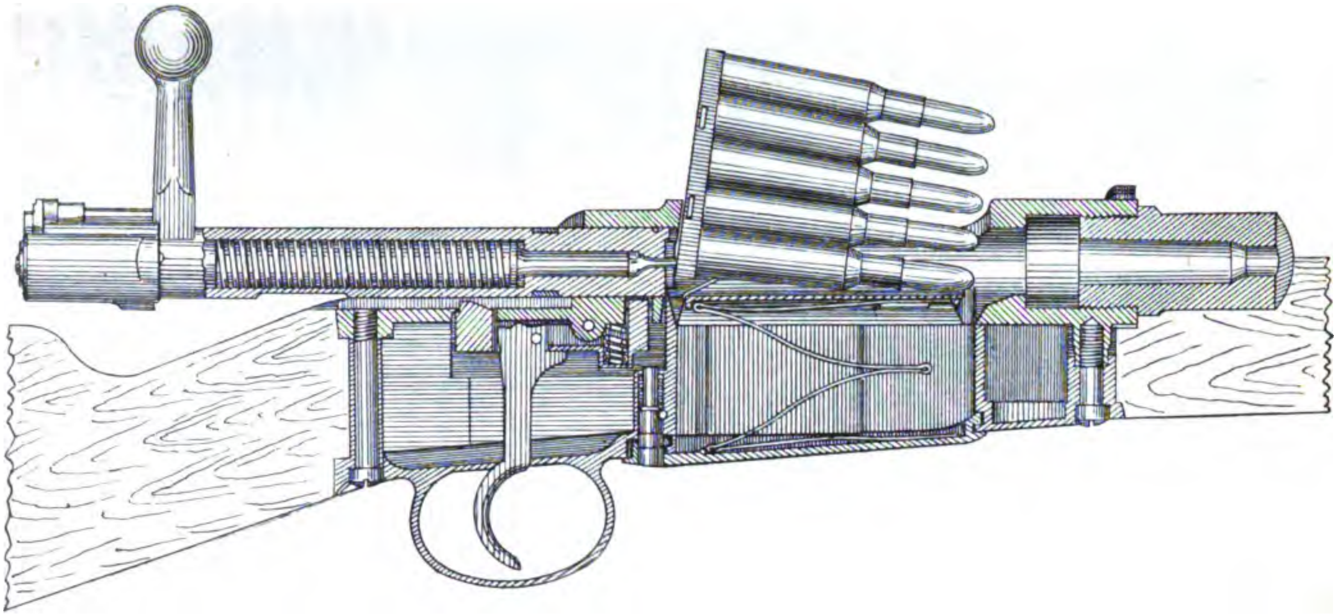


FIG. 39

PLATE XI



MAUSER ACTION, 1895

latest patterns of Continental magazine arms, of a revolving cylinder, which receives the cartridges as they are pushed down from the charger. Fig. 40 shows in section the Schönauer magazine used with the Mannlicher action. Or the magazine may lie partly to one side of the action, and may have a door at the side through which cartridges are dropped in several at a time, as in the Krag-Jorgensen (Plate XII, figs. 1 and 2); on closing the door a spring is brought into action, which presses them up so that they are supplied one by one as the bolt is operated. Another type of magazine which has been produced, though not adopted, projects above the action and to one side of it; the cartridges having been placed in this, gravity keeps them in such a position that the lowest one is always ready to be pushed forward after the bolt has been withdrawn. One still more recently produced, the Harris system, has the magazine spring under control of a small lever in the fore end, so that the left hand can put it in or out of gear and thus control the feed of cartridges from the magazine to the action. This magazine can at any time be replenished with loose cartridges. Examples of nearly all these types may be found in the military arms of the present day. But the Committee of 1886, which adopted the ·303 rifle, had a much more limited experience to guide them. Whatever doubt there might have been as to the possibility of making use of the magazine rifle on the ground of the obscuration of aim by the smoke of the discharge was entirely removed if smokeless powder was to be adopted. The Martini action could not be used with a magazine.

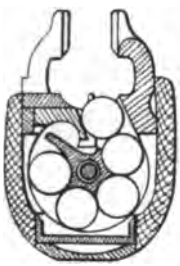


FIG. 40

The Committee had before them all the magazine actions of the time, and submitted them to examination and to severe trial, making their tests resemble so far as possible work under service conditions, rust and sand being allowed to do their worst to hamper the free working of all the parts. Under the painstaking presidency of General Philip Smith the whole question was dealt with, and the Committee finally recommended the adoption of a rifle of a modified Lee action,

PLATE XII

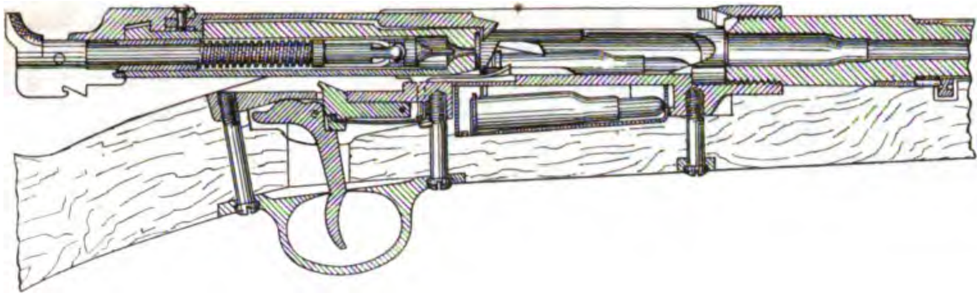


FIG. 1. KRAG-JORGENSEN ACTION, 1889

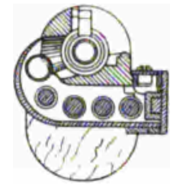


FIG. 2
KRAG-JORGENSEN
MAGAZINE,
SHOWN IN SECTION

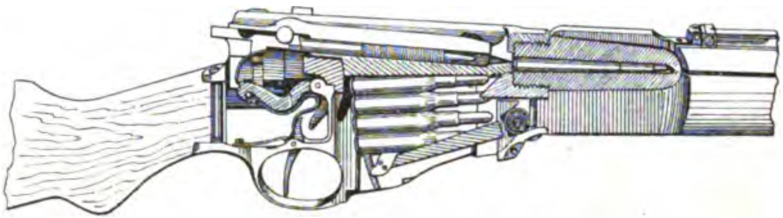


FIG. 3. LEE STRAIGHT-PULL ACTION, 1898

and a box magazine of special design into which the cartridges were placed one by one. The bore of the rifle, almost the same as Major Rubin's, was ·303, and the form and dimensions of rifling, cartridge, and chamber were laid down, at the request of the Committee, by Mr. Metford. There are seven grooves, and the spiral gives one turn in 10 inches, or 33 calibres.

This rifle, the Lee-Metford Mark I. (Plate XVIII, fig. 1), approved in December 1889, was produced when as yet no cartridge but one of black powder was available for it. With a charge of 70 grains of compressed black powder it gave a velocity of 1,850 feet per second, and the pressure in the chamber was about 18 tons to the square inch. It was sighted, however, to a scale suitable for a smokeless powder giving a velocity of 2,000 feet per second. The rifle was found to be generally satisfactory, but the shooting, as already mentioned, was by no means up to the mark. The magazine held only eight cartridges. In view of the reports received on it, a new Committee, appointed in July 1890, produced a new pattern of the rifle (Mark I.*), with a magazine holding ten cartridges, a simpler bolt, and several improvements in detail; this was approved in December 1891. This is the pattern with which the bulk of the troops are now armed. Further slight modifications were made in 1892 (Mark II.), and in 1895 (Mark II.*). In the latter year the so-called Enfield rifling was substituted for the Metford segmental grooving, and the Lee-Enfield Mark I., in other respects practically the same as the Mark II.* rifle, approved. In 1899 the Lee-Enfield Mark I.* (Plate XVIII, fig. 2), with little change in pattern but the abolition of the cleaning rod, was introduced. Plate XIII shows the general view of the action from the side (fig. 1), and from above (fig. 2). The cut-off, which blocks or releases the supply of cartridges from the magazine, according as it is pushed in or pulled out, is well seen, and also the way in which the empty cartridge-case is jerked to one side for extraction when it has cleared the chamber. Plate XIV shows the detail of the arrangement of the cartridges in the magazine, and the mode in which they rise into the chamber. Plate XV is a vertical view of the same, and very well shows the cut-off and extractor hook.

PLATE XIII

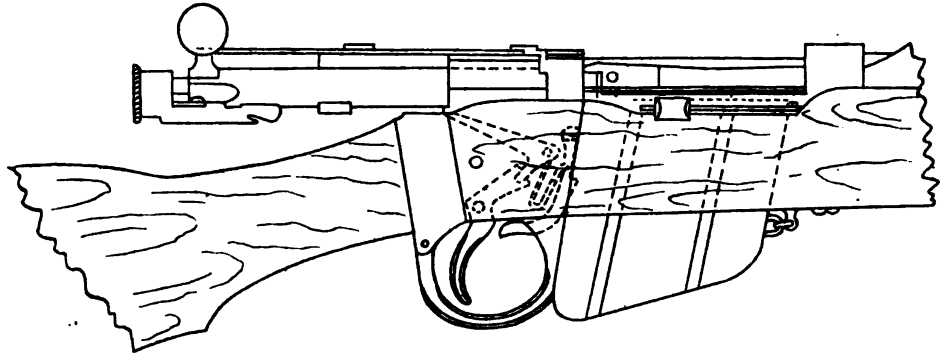


FIG. 1. LEE-ENFIELD ACTION. SIDE VIEW

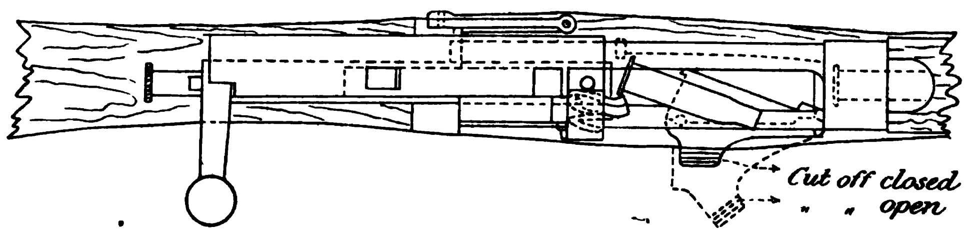
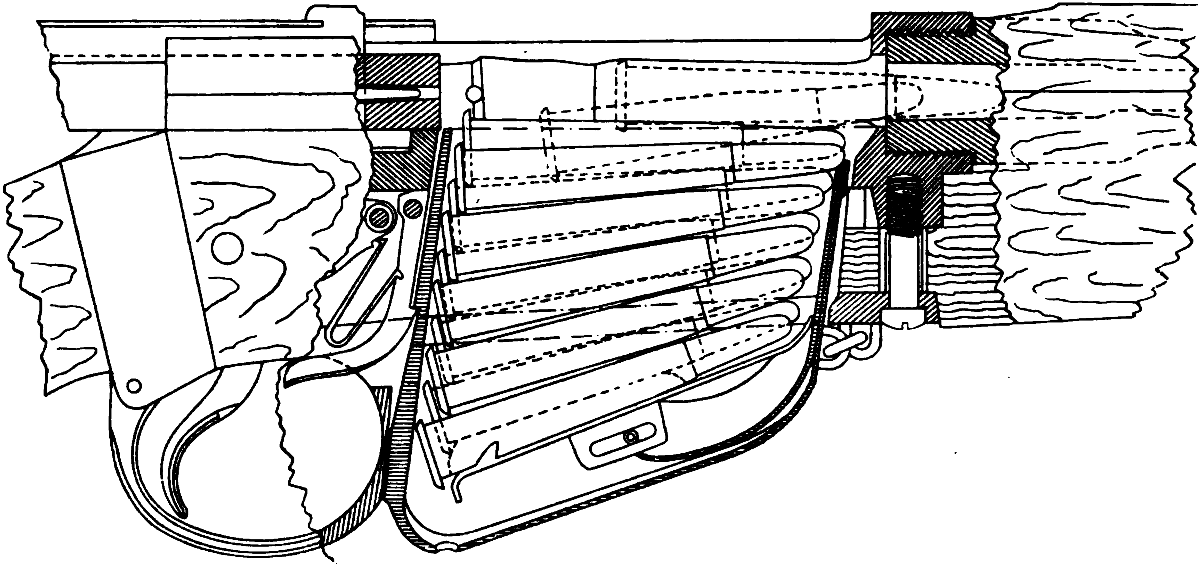


FIG. 2. LEE-ENFIELD ACTION. VERTICAL VIEW

It was not for some little time after the adoption of the ·303 that the labours of Nobel, supplemented by those of Sir Frederick Abel and others, produced the smokeless explosive known as cordite, which has ever since been used in the cartridges made for the Government arm. The developement of smokeless powders is a special subject which does not fall within the scheme of the present work. They are much more powerful, weight for weight, than black powder. For instance, the charge of cordite for the ·303 rifle weighs from 30 to 31 grains, but is equivalent in propelling power to the old charge of 85 grains of black powder used in the Martini-Henry rifle. Smokeless powder, too, is much smaller in bulk, and whereas the cartridge would contain no more than 70 grains of black powder, even when heavily compressed into a pellet, the much more powerful charge of cordite leaves a very considerable air space behind the bullet. The use of smokeless powder, and of compound bullets with a hard envelope usually either of a mixture of nickel and copper, as in the British rifle, or of steel faced with a thin plate of nickel, is general in the military arms of the present day. The principle, however, on which the bullet is fitted to the grooving is practically a revival of that which Robins mentions in the passage already quoted, that by which the bullet being of more than the full size of the bore is by the explosion forced into the grooving. The ·303 rifle has grooves about ·005 inch deep, so that the extreme measurement of the circle including the depth of the grooves, is ·303 + ·005 + ·005, or ·313 inch, and the diameter of the bullet before it is fired measures ·311 inch. The pressure of the explosion forces it into the barrel under heavy stress, and it is effectually fitted to the grooving, so that the gases are sealed from escaping past it. So complete is the sealing when this principle is properly carried out that with most modern rifles of this class there seems little or no advantage in interposing a wad between the powder and the bullet. It will thus be seen that the principle of the expanding bullet, upon which so much care and invention was bestowed, and which solved the problem of accuracy and rapid loading

PLATE XIV

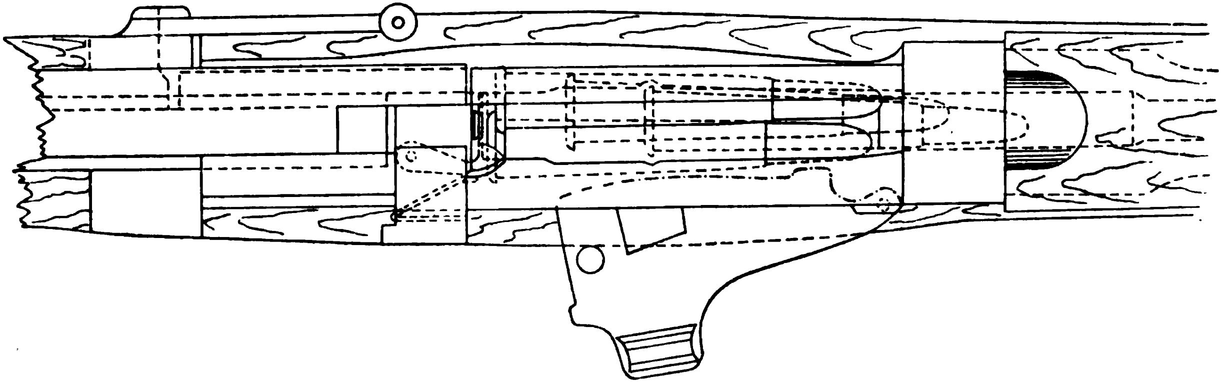


LEE-ENFIELD MAGAZINE. SECTION

in muzzle-loader and breech-loader, has been entirely departed from in the new class of military weapons.

One difficulty connected with the bullet gave some little trouble at first. The heat set up by the friction of the bullet on the bore is very considerable. It was found with the experimental ammunition first made for the ·303 that the first shot fired from a clean barrel was never seen or heard of again, while, when once the barrel had been fouled, the rifle shot satisfactorily. The only reason was that the friction of the bullet in being passed up the barrel developed heat enough to melt that part of the leaden core which lay next to it. Apparently the deposit from a shot previously fired was sufficient to reduce this heating effect. The difficulty was so great that it had to be got over by thickening the metal envelope of the bullet. It could equally have been overcome, as Sir Henry Halford pointed out in a lecture delivered at Aldershot at the time, by inserting a minute layer of some non-conducting material between the leaden core and the metal thimble. Some years ago the writer was trying a series of experiments with various loads of different smokeless powders, and a bullet of normal make which gave no trouble. In testing one particular powder at the ballistic pendulum the shooting was found to be extremely wild. On firing a series of shots through a cardboard target at a distance of only 4 or 5 yards, the reason became evident. Most of the shot holes were seen to be surrounded by one or more little black cloudy marks, sometimes showing a spiral inclination, which proved clearly enough that a spattering of very fine particles of melted lead was escaping from the base of the bullet as it flew. Why the conditions of friction with the deposit of this powder were so different from those of all other powders used with the same bullet, it would be very hard to say. Mr. Metford, in investigating the vagaries of the first shot, had been able to see the bullet in the air surrounded, as it flew, by a little cloud of melted lead consisting of particles so fine that on recovering the bullet, and weighing it, it was found to have lost only one or two grains in weight during a flight of several yards through the air. He found that if the barrel had been

PLATE XV



LEE-ENFIELD MAGAZINE. VERTICAL VIEW

plentifully greased the friction was so far diminished that the first shot did not melt.

It will easily be understood that where a very large amount of energy has to be imparted by the powder gases to the bullet in a very short time and on a very small area of base, the destructive effects of the blast of the gases upon the barrel are apt to be very marked. Every time the rifle is fired what is really quite a large blast of white-hot flame finds its way up the very narrow pipe which the bore presents. Cordite, which has many good qualities (for it keeps in hot and cold climates, is very safe to store and handle, and does not develope high pressures in the barrel), yet has one grave disadvantage. It is composed of a mixture of two of the most violent explosives known, gun-cotton and nitro-glycerine, and the temperature at which it burns is a very high one, higher than the melting-point of steel. It was soon found that the surface of the barrel, where the chamber was narrowed into the rifling, showed signs of damage when only a few rounds of cordite had been fired through it, and that a few hundred rounds were sufficient to effect very obvious injury, and to impair the velocity as well as the accuracy of the shooting.

The peculiar appearance caused by erosion, consisting first of a very minute grooving just in front of the chamber in the direction in which the gases escape up the barrel, and, in a more advanced stage, of an irregular washing away of the surface of the bore, especially at the bottom of the grooves in the breech end of the rifle, and the pitting of the surface, is familiar to all those who take an interest in this subject. On this account it was found advisable to lengthen the 'life' of the ·303 barrel by giving the gases more of the original surface of the bore to eat away, and the deeper five-grooved rifling (p. 60, fig. 27), with the grooves concentric with the bore, and with as much land as there is grooving, was substituted for Mr. Metford's more delicate grooving. At the same time some alterations were made in the loading of the cartridge, which have assisted to diminish the erosive effect, and the 'life' of a barrel when used with cordite now extends to some eight thousand rounds, a matter even more important for machine guns than for rifles. The destructive effect of erosion, while it is common in some degree to all smokeless powders, is much less developed in those which do not contain nitro-glycerine, but no such powder has as yet been produced which has been thought to fulfil the military requirements of this country (which include transport to and from all parts of the world and use in every variety of climate) so well as cordite. The labours of the Explosives Committee, now sitting, may perhaps do something towards solving the problem.

A curious fact connected with erosion, and conspicuous with cordite, is what is known as metallic fouling. It is no doubt due to the immense heat developed and to the friction of the bullet that a metallic deposit is left on the surface of the bore after firing, which is extraordinarily difficult to remove, and which tends to accumulate for a few shots, and then seems suddenly to be swept out, with the result that the amount of resistance to the bullet in passing up the barrel varies, and that irregular shooting is produced. It has even been found that this fouling will temporarily reduce the diameter of the barrel by as much as the one-thousandth part of an inch. This makes the chief difficulty in keeping the surface of the barrel clean and in good order, and necessitates the use in cleaning of the wire brush and the double pull-through of tightly fitting wire gauze.

Smokeless powders are so generally used now, and so well known, that it is not necessary to add much upon this subject. Most of those in vogue among foreign nations for their military rifles, as well as those, other than cordite and ballistite, and one or two less well known, used in sporting rifles, are made without nitro-glycerine, and do not have the same degree of destructive effect on the barrel, although erosion to some extent takes place with all of them. They consist mainly of nitro-cellulose, that is, some sort of nitrated fibre brought to a condition in which it does not give too violent an explosion. Schultze and 'E. C.' were the pioneers of powders of this kind in sporting guns, but there are now many, and they are improving every year. All have the advantage that they leave very little fouling in the barrel, and this tends to accuracy of shooting. On the other hand, what little deposit is left by some of the powders seems to stick fast and to be difficult to remove, and has a decided tendency to rust the surface of the bore, making it very difficult to keep it properly clean. One point in which these powders are generally capable of improvement is conspicuous to the marksman, that with all of them there seems a tendency to irregularity of ignition, and of friction in the bore, which gives an occasional shot wide of the general group. But in spite of this the shooting obtained at all ranges with modern rifles is, on the whole, superior to that of the older types. The average deviation from the point of mean impact of a normal group of shots at 500 yards fired with the Martini-Henry from the fixed rest was about 11 inches; with the ·303 it is about 7 inches.

The difference is very marked, if we take the record of prize shooting at Bisley and elsewhere, between the scoring with the two rifles, but it is fair to say that had the comparison been made, not with this rifle, but with the Metford military breech-loader, of the same bore as the Martini-Henry, which for so many years was conspicuous at Wimbledon and Bisley, it would probably not have been in favour of the more modern rifles. The ·303 rifle will give good shooting at a target up to 1,000 yards, although it is by no means incapable of missing at that distance. So excellent was the shooting at an 8-inch bullseye at 200 yards from the knee or lying down with the Martini-Henry, that it seemed as if it could hardly be improved on, scores of 33 out of 35 being frequent, scores of 34 not uncommon, and the full number of 35 points being occasionally made. Since the advent of the ·303 rifle the scores have been decidedly higher, long strings of 34's and a quantity of 35's being constantly recorded. At 500 yards full scores became ridiculously common from any steady position, and in 1901 the bull's-eyes of both the short and the mid range targets had to be reduced, the former from 8 to 7 inches, and the latter from 24 to 20. Thése are very small objects to hit, yet scores of 100 points or more out of a possible 105 in the seven shots at 200, 500, and 600 yards are not infrequently made.

One element, undoubtedly, which has favoured the high scores made with the ·303 rifle, is the absence of any material recoil. The kick of the Martini-Henry was a terror to most of those who used it, and especially to the unfortunate recruit who for the first time experienced its violence. There were few men who did not find that a comparatively small number of shots fired during the day were enough to take the edge off the accuracy of their shooting. Many were the bruised shoulders for which this rifle, and, indeed, all others of its class, were answerable. Now this is all changed, and one of the great advantages of the new rifles is that the instruction of the soldier has been made very much more easy in consequence.

The penetration obtained from the new rifles was astonishing. Yet, in spite of their increased power, it did not follow that the military effectiveness of these weapons was all that could be desired. The ·303 rifle, if the bullet is directed to the right place, will pierce the brain of an elephant and kill him. It will go through a large animal from side to side, but if it happen to penetrate without touching a vital part it will do very little damage. It does not, in fact, expend upon the tissues it meets with in its course the whole of the energy contained in it. It can only be made to do so by so arranging matters that on impact it opens or spreads, and so creates for itself a resistance sufficient to overcome its motion before penetration is complete. A dangerous or charging animal requires to be stopped on the instant. It is of no avail to penetrate it with a wound that produces no immediate effect, even though hours afterwards it may be fatal. The shot must produce widespread and instantaneous damage. It was found, and not unexpectedly, that in Chitral the effects of the wounds inflicted upon the enemy were really very slight. A charging dervish or an Eastern hillman at close quarters must be reckoned as dangerous game. This is why the original bullet made for the ·303, completely sheathed at the point and known as Mark II. bullet, was varied and made hollow-pointed, in a way which shocked the peace delegates at the Hague Conference. Not that the Mark IV. bullet and the Dum-dum were really so inhuman as their detractors on that occasion attempted to show, for their experiments were made with an imitation of the real Dum-dum bullet which was far from being a facsimile of it. The Mark IV. bullet, the core of which was made of pure lead, and which had a hollow head, was manufactured during 1898 and 1899, but in the summer of the latter year it was found, as those who were at the Bisley meeting will remember, that under some conditions the core was occasionally blown through the envelope, and that accidents could occur. Mark V. bullet, similar in shape, but rather harder, and consequently with less expansive power, was then substituted for it, but on the commencement of the South African War it was decided to use again only Mark II. bullet, and thus it happens that on the British side, and, we may suppose, on that of the Boers (except in so far as sporting rifles and ammunition may have been used), the war has been conducted with that regard to humanity which, if it diminish the horrors of it, tends unfortunately to its prolongation.

The Mark IV. bullet seems to have been slightly inferior to the ordinary Mark II. bullet in accuracy, and the same may be said of the Indian Dum-dum bullet, in which the expansive property is obtained by exposing the leaden core at the nose of the bullet. The construction of these bullets is shown on p. 142.

It must not be supposed that the bolt actions of the present day are not immensely improved from the original patterns, such as that of the needle-gun and others which followed it. With these there was always some danger that in the rapid closing of the bolt the point of the needle or striker might come into contact with the cartridge, and explode it before the bolt was properly locked. Safety devices of various kinds have entirely obviated this defect, which thirty years ago was a sufficiently fertile source of accidents to give an almost undisputed preference to the falling-block system in this country for a good many years. In these days no one would attempt to maintain that the bolt action is less safe than other kinds. It has been made in hundreds of thousands, nay, in millions, to furnish the military weapons of most Powers, and accidents with it are almost unknown. Its manipulation is extremely simple. Generally speaking, there is a projecting lever on the right side with a knob at the end to afford a convenient hold. If this lever is sharply turned upward to the left a quarter of a circle, the lugs, of which there are usually two, holding the bolt in place during the discharge, are disengaged, and the whole bolt can be drawn directly backwards. The extractor hook, which has ridden over the rim of the cartridge while it was being pushed home, withdraws it; primary extraction, that is, a specially powerful movement to start the empty shell out of the chamber, being given by an inclined plane during the first part of the upward movement of the lever. It is a simple matter to arrange some little stud or projection which shall catch against one side of the base of the cartridge case when it has been drawn clear of the chamber, and jerk it clean away to one side. No difficulty in extraction is experienced with a well-made rifle and ammunition; indeed, the principal trouble, and one which has been extremely well overcome in the English military arm, is to prevent the ejection of the cartridge being so violent as to strike with unpleasant force the man next to the firer, or some one in the rank behind him. The cocking of the action is in some systems accomplished during the first sideways movement of the lever, but in that case it entails something of an additional strain upon the hand during that portion of the motion, which is also the time when the primary extraction is made. In others, as in that of the British rifle, the cocking is the last thing done when the bolt is almost closed, the cocking piece in the bolt being held back by the sear nose, which engages against it as the bolt is pushed forward. The various bolt systems differ chiefly in small details. With some the cartridges have projecting rims, which limit absolutely the extent to which the cartridge can advance into the chamber. With others the rim is replaced by a groove cut in the brass body of the cartridge just in front of the base, and in this the extractor hook engages. This system appears less satisfactory than the other, but nevertheless seems to work excellently in practice, as the cartridge in fact is not driven forward unduly into the chamber. When the rim is dispensed with the cartridges take up less room in packing. Some bolt actions, again, have a revolving head, which enables the hinder part of the bolt to be turned independently of a short part which adjoins the cartridge. By this means the bolt is unlocked without the end of it being forced to revolve against the head of the cartridge. Such is the arrangement in the Lee action. The revolving head appears on the whole to be the preferable system, but, as is the case in so many departments of practical mechanics, theoretical excellence is comparatively unimportant if the manufacture be strong and sound.

This saying, in fact, may be held to apply to all the varieties of modern military arms used by the different nations. One may be more perfect than another in some one respect, but, generally speaking, the differences in speed of fire, ballistic properties, &c., are comparatively very small, and any one of these rifles may be held to be admirably efficient as a man-killing machine. It is not worth while to refine too much on the various points of comparison which arise upon inspection of a comparative table of the dimensions and systems distinguishing the military weapons of the present day. There are two or three countries, for instance, which have adopted a bolt action requiring only a direct pull and push to actuate it, and not the double motion of turning the bolt as well as sliding it forward or backward. In this way some degree of additional rapidity is certainly gained, though when the weapons are in hands well accustomed to them the difference in speed can only be very minute. In most straight-pull systems the advantage gained in obtaining a primary extraction at enormously favourable leverage during the turning motion of the bolt is lost, and in any case something of complication is added to the mechanism. But with the perfection and accuracy of modern manufacture straight-pull actions answer practically well enough. If we may except that of the American 6 mm. rifle, which has what is known as the Lee straight-pull action (Plate XII, fig. 3), but is not really a straight-pull action at all, they all rest on a very simple principle, that of having the bolt in two parts, one a kind of sleeve over the other, and actuated by what is really a screw mechanism. The Swiss rifle has a straight-pull action, of which the earlier pattern is somewhat large and heavy. The Mannlicher straight-pull bolt, which is in use in the Swiss carbine, and that of the Mauser are much smaller and more compact. Another straight-pull action, which bears a great resemblance to those just mentioned, is one designed by Sir Charles Ross, which has not yet been made in any quantity. But it may be doubted whether the straight-pull action on its merits will ever supersede the ordinary bolt action except in so far as it is specially applicable to the requirements of automatic mechanism.

The rapidity of fire gained by the use of the bolt action combined with the magazine consists, as has been already pointed out, mainly in the fact that it is a device for extremely rapid loading; that what is either really or practically a single motion of the bolt backward, and another single motion forward, extracts and ejects the fired cartridge, inserts a fresh cartridge into the chamber ready for firing, and also cocks the lock, and leaves it so that only the trigger requires to be pulled. The saving of time thus effected is not to be measured only by the rapidity of this action. Anyone who, especially as a youngster, has used one double gun at a stand where pheasants or partridges were coming thick and fast, must know how great a drawback it is to his shooting to have to fumble for cartridges in his pocket, to turn them right end foremost, and then to load and close his weapon. The simpler the motions involved, the more attention will be given to the essential movements of aiming and firing. A well-practised manipulator of a magazine rifle may be compared to the man who has one or two loaders, and who whenever he has fired two barrels has another gun ready for discharge slipped into his hand; he has almost nothing to divert his attention from his game. The heat of the barrel from magazine fire is so great that it is necessary to attach a wooden handguard over it, if not to sheathe it almost completely in wood.

It was evident enough when the supply of cartridges into the chamber of the rifle could be satisfactorily effected by the direct movement of the bolt, that either by the recoil of the rifle, or by some other application of a part of the force of the shot just fired, the loading could be effected automatically as in the Maxim and other machine guns, with which firing can be continuously carried on from a single barrel. The difficulties involved are largely those of doing the work with a minimum of complication and of weight in the machinery. A further grave difficulty is the supply of ammunition in sufficient quantity to justify the extremely rapid rate of fire which can be obtained from a weapon in which the hand does not have to be shifted nor even a finger moved from one trigger to another. Yet this can hardly be considered an insuperable objection. The rapidity, and, if one may so call it, the smoothness of the fire, will be out of all proportion to the mere advantage in time gained by the more rapid loading. It is the disturbance of the aim, the distraction of the attention from the object, the shifting of the rifle in the hands to load, and consequently of the whole centre of gravity of the body, and especially of the head, shoulders, and arms, demanding for every shot an entire readjustment of the whole body, that delays aiming, and consequently firing. With automatic loading these causes of delay disappear, and it is evident that the greatest possible use may be made of the very briefest opportunities of fire. With black powder real rapidity was not to be thought of. The cloud of smoke, whether of a man's own making or from his neighbours' rifles, made perceptible intervals in the firing a matter of course. This is no longer the case. Although automatic loading mechanism is one of the problems that have not been entirely solved, in the sense that there is room yet for much simplification, it would only require that one of the chief military Powers of the world should adopt it to force all the others to follow suit. Such a new departure would give a very real advantage, but at the same time, as is the case with the magazine rifle, the moral advantage obtained would probably be out of all proportion to the actual mechanical improvement. Quite a number of automatic rifle actions have been arranged, one by Griffiths and Woodgate, and several by Mannlicher and other designers. The first desideratum would appear to be such an action as could be applied with comparatively little expense to an existing magazine rifle, and here a straight-pull mechanism would seem to have the advantage. Ingenious as are many of the patterns that have been produced, in them the trouble experienced with automatic pistols is even more intensified, owing to the severer stresses and the greater length of the rifle cartridge; yet the solution of the problem in a practical form seems merely to be a matter of time. When it does come the soldier, so far from being denied access to the working parts of the breech mechanism, will almost necessarily be taught how to clean and to assemble the mechanism, and will be held responsible for its efficient working.

We have spoken of automatic loading as a probable developement in the future. It remains to be seen what other changes in military arms time will bring. The difficulties at the present time in keeping barrels from rust and from deterioration in use are so great that there may possibly be a reconsideration before long of the question whether calibres of less than 7½ mm. (·295) do not lose more in this respect than they gain in flatness of trajectory and lightness of ammunition. Unfortunately it cannot be pretended that military rifles of 7½ to 8 mm. are by any means free from the same defects. The future of this part of the question depends to some extent on the future of metallurgical science. The difficulty might be met were it possible to change the constitution of steel or to substitute for it another metal less easily oxidised and capable of better resistance to the destructive effects of the explosive, and of the friction from a hard-coated bullet. A remedy is more likely to be found in some modification of the explosive which shall give with comparatively low temperatures and pressures an amount of work at least equal to that given by existing powders. Here is a wide field for the chemist. If he can even approximately solve this problem, we may see a reduction of calibres beyond anything yet attempted. Short of such sweeping changes there is room for considerable improvement in the accuracy of firearms. Special attention needs to be given to the quality of the residuum of the explosive, and to the elucidation of those causes of irregular ignition and friction in the barrel which are answerable at the present time for many of the disappointments of marksmanship. Whether or not the bayonet is to be considered as a serious weapon in coming wars, the rifle of the future is likely to be lighter than that of the present day rather than heavier.

In dealing with the developement of destructive weapons it would seem to be a sad truth that the more terrible and destructive they can be made the better will it be in the long run for the cause of humanity. If wars, however bloody, are short, the total losses in them will not be greater than under the old conditions, while the indirect injury they inflict will be far less than in the case of prolonged and ineffective struggles. Just as the strength of a big man gives him no advantage in a duel with pistols over a small antagonist who would have no chance with him in a hand-to-hand struggle, so a great nation must, if only war be deadly enough, pause before facing the grave risks of heavy losses inseparable from a campaign against even a small nation well armed and equipped. If weapons can be made deadly enough to render annihilation of one party or of the other to a fight a certainty, the reign of universal peace cannot fail to be very near at hand.

The pictures and particulars which follow of the arms of the principal civilised nations of the world are not without interest, but the reader must be warned against drawing his deductions too widely from the details given. Thus, although the 6½ mm. Mannlicher rifle has a higher velocity, and in the first part of its flight a flatter trajectory than the rifles of 7 and 7½ mm., which appear alongside it, the blow inflicted by it is certainly not so great at long distances. Similarly in the mechanism and system of any one rifle adopted there are various differences, the advantage and disadvantage of which may easily be exaggerated, since they amount as a rule only to a very small percentage on the total effectiveness. It may be said of all the military magazine arms of the present day that they are very well adapted for their purpose.

Much trouble has been taken in obtaining the particulars connected with the different rifles, and the author is much indebted to Major H. W. W. Barlow, R.A., for verifying many of them. Although machine-made arms are wonderfully uniform in dimensions, a certain margin has to be allowed, owing to the wear of the tools, within which their measurements may vary. The difference, for instance, of half a thousandth of an inch in the calibre or the depth of the grooving, and the small variations in the length or weight of the cartridge and bullet, which are constantly found between one sample and another, are inevitable, but for practical purposes immaterial. Although there is a standard weight for each rifle, the mere difference in the compactness of the wood of the stock may make one rifle as much as ten ounces heavier than another of exactly the same pattern. In the present table some of the particulars have been taken from actual specimens, and may in this way not be absolutely normal. Nor must it be forgotten that patterns often change in small details, and that in such points as the kind of explosive adopted for any rifle and the amount of the charge there is no permanence.

The initial velocity is not easy to arrive at with perfect certainty, and in many cases the observed velocity (o.v.) at 90 feet, as obtained by actual experiment, has been given. The figures representing the pressure in tons must be accepted with caution; some of them seem to be in any case only approximate, while the nominal ton of pressure can hardly represent a true stress of a ton, or some of the pressures given would be higher than steel could stand.

In comparing the values of $\frac{W}{d^2}$, which represent *ceteris paribus* the effectiveness of the bullet, it will be noticed that the various rifles do not differ very greatly except the United States ·236 rifle and the Spanish Mauser, which are inferior to the others. The absolute value for comparative purposes of the figures must be discounted by the fact that the friction of the air on the sides of the bullet tells more upon a light one than upon a heavy one of the same length, and that the shape of the head is an important factor in flight.

—	AUSTRIA-HUNGARY	BELGIUM	DENMARK
Designation	Mannlicher	Mauser	Krag-Jorgensen
Date of pattern	1895	1889	1889
Calibre in inches	·315	·301	·315
Length	4 ft. 2 in.	4 ft. 2½ in.	4 ft. 4¾ in.
Weight	8 lb. 5½ oz.	8 lb. 11 oz.	9 lb. 11¾ oz.
Weight with bayonet	8 lb. 4¾ oz.	9 lb. 10¼ oz.	10 lb. 4½ oz.
Magazine — System	fixed vertical box	detachable vertical box	fixed horizontal box, with door at side
Magazine — Clip or charger	clip	charger	—
Magazine — No. of cartridges	5	5	5
Bolt movement	Straight pull	turning	turning
Barrel — Length in inches	30·1	30·7	32·9
Barrel — Grooves — No.	4	4	6
Barrel — Grooves — Width	·138	·172	·118
Barrel — Grooves — Depth	·008	·0065	·0075
Barrel — Grooves — Shape	ratchet	concentric	concentric
Barrel — Grooves — Twist in calibres	31·3—right	32·5—right	37·5—right
Barrel — Grooves — Angle of twist	5° 44′	5° 31′	4° 47′
Cartridge — Length in inches	2·99	3·07	2·99
Cartridge — Weight in grains	455	441	463
Cartridge — Groove or rim	rim	groove	rim
Charge — Explosive	nitro-cellulose	nitro-cellulose, Wetteren L3 (Libbrecht)	nitro-cellulose, flake
Charge — Weight in grains	42·4	37·04	34
Bullet — Length in inches	1·25	1·2	1·18
Bullet — Diameter in inches	·323	·311	·323
Bullet — Weight in grains	244	219	237
Bullet — Envelope	steel	cupro-nickel	cupro-nickel
Initial velocity, f.s.	2,034	2,034	1,968
Value of W/d^2	·334	·331	·326
Pressure in tons	19·0	19·7	15·1

FIG. 1. AUSTRIA-HUNGARY

FIG. 2. BELGIUM

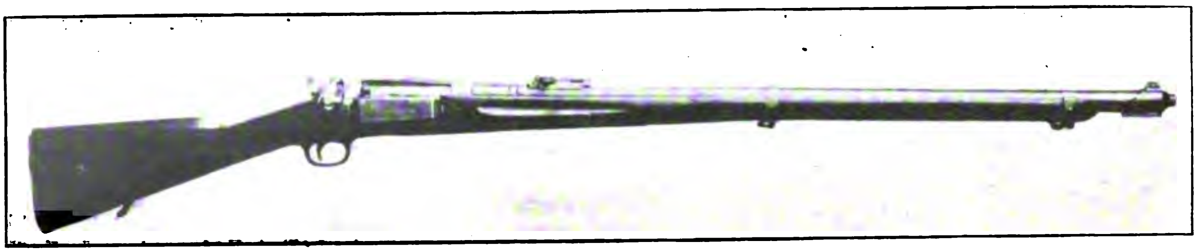


FIG. 3. DENMARK

PLATE XVII

FIG. 1. FRANCE

FIG. 2. GERMANY

—			FRANCE	GERMANY	HOLLAND
Designation			Lebel	Mauser	Mannlicher
Date of pattern			1886	1898	1895
Calibre in inches			·315	·311	·256
Length			4 ft. 3 in.	4 ft. 1 in.	4 ft. 3 in.
Weight			9 lb. 3½ oz.	9 lb. 4 oz.	9 lb. 11 oz.
Weight with bayonet			10 lb. 1½ oz.	10 lb. 0 oz.	10 lb. 8¾ oz.
Magazine		System	tube in fore end	fixed vertical box	fixed vertical box
		Clip or charger	insertion of single cartridges	clip	clip
		No. of cartridges	8	5	5
Bolt movement			turning	turning	turning
Barrel		Length in inches	31·5	29·1	31·1
	Grooves	No.	4	4	4
		Width	·164	·173	·110
		Depth	·0059	·0065	·0065
		Shape	concentric	concentric	concentric
		Twist in calibres	30·0—left	30·2—right	31·8—right
		Angle of twist	5° 59′	5° 56′	5° 39′
Cartridge		Length in inches	2·95	3·22	3
		Weight in grains	447·5	431·5	464
		Groove or rim	rim	groove	rim
Charge		Explosive	nitro-cellulose flake B.F. Vieille	flake powder	Troisdorf
		Weight in grains	42·43	40·75	36·26
Bullet		Length in inches	1·26	1·23	1·23
		Diameter in inches	·323	·3189	·263
		Weight in grains	231	227	162
		Envelope	cupro-nickel	steel, coated with cupro-nickel	steel, coated with cupro-nickel
Initial velocity, f.s.			2,073	2,000 (o.v.)	2,433 (o.v.)
Value of W/d^2			·320	·322	·336
Pressure in tons			18·8	20·3	23·5

		GREAT BRITAIN	GREAT BRITAIN
Designation		Lee-Metford Mark I.*[1]	Lee-Enfield Mark I.*
Date of pattern		1892	1899
Calibre in inches		·303	·303
Length		4 ft. 1½ in.	4 ft. 1½ in.
Weight		9 lb. 8 oz.	9 lb. 4 oz.
Weight with bayonet		10 lb. 7½ oz.	10 lb. 3½ oz.
Magazine	System	detachable vertical box	detachable vertical box
	Clip or charger	insertion of single cartridges	insertion of single cartridges
	No. of cartridges	8	10
Bolt movement		turning	turning
Barrel	Length in inches	30·2	30·2
Barrel — Grooves	No.	7	5
	Width	·113	·0936
	Depth	·004	·005
	Shape	segmental	concentric
	Twist in calibres	33·0—left	33·0—left
	Angle of twist	5° 26′	5° 26′
Cartridge	Length in inches	3·05	3·05
	Weight in grains	415	415
	Groove or rim	rim	rim
Charge	Explosive	cordite 60 cords	cordite 60 cords
	Weight in grains	31·5	31·5
Bullet	Length in inches	1·25	1·25
	Diameter in inches	·311	·311
	Weight in grains	215	215
	Envelope	cupro-nickel	cupro-nickel
Initial velocity, f.s.		2,000	2,000
Value of W/d^2		·326	·324
Pressure in tons		16·5	16·5

[1] The plate represents the Lee-Metford Mark I. rifle, the only visible difference being in the shape of the hand-guard, which in Mark I.* is rounded at the ends as in the Lee-Enfield Mark I.*

PLATE XVIII

FIG. 1. GREAT BRITAIN, LEE-METFORD

FIG. 2. GREAT BRITAIN, LEE-ENFIELD

PLATE XIX

FIG. 1. ITALY

FIG. 2. NORWAY

—		ITALY	NORWAY	ROUMANIA
Designation		Mannlicher Carcano	Krag-Jorgensen	Mannlicher
Date of pattern		1891	1897	1893
Calibre in inches		·256	·254	·256
Length		4 ft. 2⅓ in.	4 ft. 2 in.	4 ft. 0¼ in.
Weight		8 lb. 6 oz.	9 lb. 5 oz.	8 lb. 12⅓ oz.
Weight with bayonet		9 lb. 3 oz.	9 lb. 13 oz.	9 lb. 9⅓ oz.
Magazine	System	fixed vertical box	fixed horizontal box with door at side	fixed vertical box
	Clip or charger	clip	—	clip
	No. of cartridges	6	5	5
Bolt movement		turning	turning	turning
Barrel	Length in inches	30·7	30	28·4
Barrel, Grooves	No.	4	4	4
	Width	·118	·118	·138
	Depth	·006	·0055	·006
	Shape	concentric	concentric	concentric
	Twist in calibres	31·1—right	31—left	31—right
	Angle of twist	5° 46′	5° 47′	5° 47′
Cartridge	Length in inches	3·27	3·13	3
	Weight in grains	332	372	350
	Groove or rim	groove	groove	rim
Charge	Explosive	ballistite or selenite	nitro-cellulose	nitro-cellulose
	Weight in grains	B. 31·5 S. 35·0	36	36
Bullet	Length in inches	1·2	1·3	1·24
	Diameter in inches	·267	·263	·264
	Weight in grains	162	156	162
	Envelope	cupro-nickel	steel, coated with cupro-nickel	steel, coated with cupro-nickel
Initial velocity, f.s.		2,395 (o.v.)	2,300 (o.v.)	2,291 (o.v.)
Value of W/d²		·337	·331	·337
Pressure in tons		17·1	19·0	26·7

—		RUSSIA	SPAIN	SWITZERLAND
Designation		3-line (Nagant) Mauser	Mauser	Schmidt-Rubin
Date of pattern		1891	1896	1893 [1]
Calibre in inches		·300	·276	·293
Length		4 ft. 3¼ in.	4 ft. 1 in.	4 ft. 3¾ in.
Weight		9 lb.	9 lb. 6¾ oz.	9 lb. 13½ oz
Weight with bayonet		9 lb. 12 oz.	10 lb. 5¼ oz.	10 lb. 13¾ oz.
Magazine	System	fixed vertical box	fixed vertical box	detachable vertical box
	Clip or charger	charger	charger	charger
	No. of cartridges	5	5	12
Bolt movement		turning	turning	straight pull
Barrel	Length in inches	31·5	29·05	30·7
Barrel — Grooves	No.	4	4	3
	Width	·150	·1535	·150
	Depth	·007	·0055	·0055
	Shape	concentric	concentric	concentric
	Twist in calibres	31·7—right	31·4—right	36—right
	Angle of twist	5° 40′	5° 43′	4° 59′
Cartridge	Length in inches	3	3	3
	Weight in grains	363	377	430
	Groove or rim	rim	groove	groove
Charge	Explosive	nitro-cellulose	nitro cellulose	nitro-cellulose
	Weight in grains	33	38	29
Bullet	Length in inches	1·19	1·21	1·18
	Diameter in inches	·307	·284	·319
	Weight in grains	214	172	213
	Envelope	cupro-nickel	cupro-nickel	steel (head only), and paper patch
Initial velocity, f.s.		1927 (o.v.)	2,200	1,940 (o.v.)
Value of W/d^2		·324	·310	·341
Pressure in tons		18·4	22·2	17·1

[1] The pattern of 1893 differs little from that of 1889 shown in the plate. The action bolt is rather shorter and lighter.

FIG. 1. RUSSIA

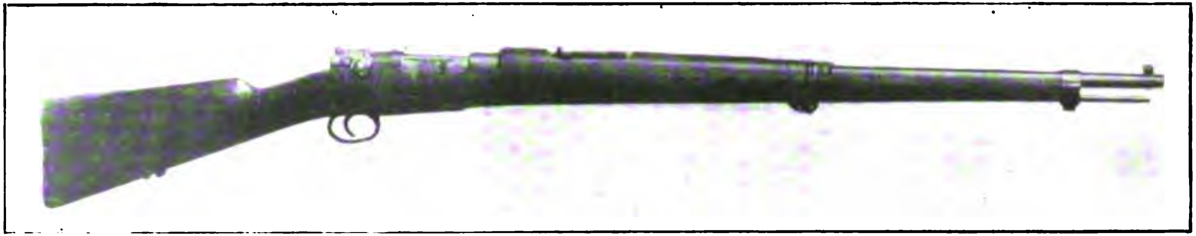


FIG. 2. SPAIN

FIG. 3. SWITZERLAND

PLATE XXI

FIG. 1. TURKEY

FIG. 2. UNITED STATES, ARMY

—	TURKEY	UNITED STATES (ARMY)	UNITED STATES (NAVY)
Designation	Mauser	Krag-Jorgensen	Lee 'Straight pull'[1]
Date of pattern	1893	1894	1898
Calibre in inches	·302	·3	·236
Length	4 ft. 0¾ in.	4 ft. 1 in.	3 ft. 11⅓ in.
Weight	9 lb. 2 oz.	9 lb. 8¾ oz.	8 lb. 8½ oz.
Weight with bayonet	10 lb. 8¼ oz.	10 lb. 8⅓ oz.	9 lb. 4⅓ oz.
Magazine — System	fixed vertical box	fixed horizontal box with door at side	fixed vertical box
Magazine — Clip or charger	charger	—	charger
Magazine — No. of cartridges	5	5	5
Bolt movement	turning	turning	straight pull
Barrel — Length in inches	29·03	30	28
Barrel — Grooves — No.	4	4	6
Barrel — Grooves — Width	·173	·166	·100
Barrel — Grooves — Depth	·0055	·0045	·005
Barrel — Grooves — Shape	concentric	concentric	segmental
Barrel — Grooves — Twist in calibres	33—right	33·3—right	31·8—right
Barrel — Grooves — Angle of twist	5° 26′	5° 23′	5° 39′
Cartridge — Length in inches	3	3	3·11
Cartridge — Weight in grains	417	408	311
Cartridge — Groove or rim	groove	rim	groove
Charge — Explosive	nitro-cellulose	nitro-cellulose	nitro-cellulose
Charge — Weight in grains	40·9	41·5	32·4
Bullet — Length in inches	1·2	1·26	1·03
Bullet — Diameter in inches	·310	·308	·243
Bullet — Weight in grains	213	219	112
Bullet — Envelope	steel, coated with cupro-nickel	steel, coated with cupro-nickel	copper, nickel-plated
Initial velocity, f.s.	3,004 (o.v.)	1,869 (o.v.)	2,489 (o.v.)
Value of W/d^2	·322	·337	·275
Pressure in tons	19·0	17·0	22

[1] Recently discarded in favour of the rifle used by the U.S. Army.

We have given the rate of twist of the rifling both in calibres and in angular measurement. The latter is not commonly given, but it shows what the diversion of the surface of the bullet is from the straight line.

The Italian Mannlicher is the only modern rifle with an increasing spiral. It begins at the breech with one turn in 19¾ inches, and ends with one in 8¼ inches at the muzzle. It may be noted that with the Krag-Jorgensen rifle a charger can be used, but we believe that it is not usually supplied.

Japan adopted in 1900 a rifle (which we have not been able to illustrate) of ·256 calibre, having the Mauser action and the Lee magazine with a movable bottom, and loading from a charger. Its observed velocity at 90 feet is 2,286 f.s., and it does not largely differ in dimension and arrangement from other recent rifles of the same calibre. The sheath of the bullet, however, is made of copper. The bullet weighs 163 grains.

The United States 6 mm. Navy rifle has proved a failure. It was found necessary to lighten the bullet in order to reduce the pressures, and consequently the rifle became comparatively ineffective. Colonel Rubin has succeeded in producing an experimental rifle of 6 mm. with an initial velocity of 2,625 f.s., the weight of the bullet being 138 grains. The velocity is obtained partly by lengthening the barrel and partly by altering the form of the cartridge so as to burn a large charge without increasing the pressure.

Many have been the criticisms to which the British service rifle has been subjected from both competent and incompetent judges—principally, indeed, the latter. Every detail of its parts seems to have been called in question, and although in many respects it has stood the practical test of service very satisfactorily, there are undoubtedly points in which with the greater knowledge and experience of the present day we should not follow, if we were starting afresh, the lines upon which it was designed.

We have already spoken of the bolt, which, although it has really met the demands made upon it by the service cartridge with ample success, yet is somewhat deficient in strength as compared with actions designed for higher pressures, especially at the head. The average pressure (and it does not vary much) given by the service ammunition is from 14 to 15 tons per square inch; the bolt is ample to resist pressures up to 20 tons, but in considering the margin of safety to be given, it is not the average pressure which has to be considered, but the abnormal stresses of an occasional shot which from some cause or another, rather difficult to define, may (though it very rarely happens with cordite) give an excessive pressure. To meet this, a margin of strength of about 25 per cent. is usually allowed. The bolt of the Lee-Metford is good up to a pressure of some 24 tons to the square inch, and probably will in fact resist considerably more. There are some foreign rifles which are designed for much higher average pressures than the ·303.

It may be regarded as certain that the members of the Committee of fourteen years ago, if they were sitting again now to recommend a magazine rifle *de novo*, would not adopt precisely the present pattern of bolt; nor, we may be very sure, would they again recommend what was at that time decided only after much debate, the adoption of a rifle with a magazine only intended for occasional use, and which can only be filled with cartridges inserted one by one, to be held in reserve against some moment when it may be important to pour in an exceptionally rapid fire for a few seconds.

The whole tendency of the present day is to adopt any practical expedient which will give a continuous rapid fire, because there are moments which have to be seized, and which may last much longer than the time it takes to empty a magazine once, when it is essential to bring to bear upon the enemy the hottest fire that it is possible to deliver. These occasions are undoubtedly more frequent in defence than in attack, for in delivering an attack men must expose themselves in advancing, and during that time cannot fire. A defence is but little concerned with moving, and whenever it sees an exposed target can pour in fire upon it. It is probably owing in part to this difference that our troops in South Africa have not felt themselves at a disadvantage in being armed with what is after all for practical purposes a single loading rifle. The magazine of the British rifle can be emptied in from 10 to 20 seconds, after which the rate of fire is no greater than it was with the Martini-Henry, 15 to 20 per minute in skilled hands. With charger or clip loading the rate of fire can be maintained at double this speed so long as ammunition is to hand.

The great difficulty of maintaining fire in these days is that of keeping up the supply of ammunition, a difficulty which is undoubtedly more serious with constant magazine fire than when the magazine fire is only occasional ; and there is, of course, a tendency to waste ammunition. Modern cartridges are small. Fig. 41 shows the cartridge of the 7 mm. (·275) Mauser rifle, fig. 42 that of the 6½ mm. (·256) Mannlicher, and fig. 43 that of the 6 mm. (·236) U.S. Navy rifle. The Mannlicher cartridge has a rim and the others grooves. The difference in size and weight between these and the military cartridges of an earlier date will at once be seen. They are easily spilt; and we should probably get some astonishing figures if we could know how much ammunition had been dropped unused on the ground by British troops in South Africa. The writer has been assured by an officer who himself carried a rifle in much of the fighting of the Natal Field Force, that his personal experience was that from 25 to 30 per cent. of the cartridges he carried leaked out from under the flap, or at the ends, of his pouches, and were lost. A thick leather pouch is certainly one of the most un-

FIG. 41

FIG. 42

FIG. 43

suitable receptacles for carrying the small cartridges of the present day that can be imagined, however admirable its qualities may have been in connection with the use of the musket 100 years ago. It may be doubted whether the waste of cartridges is not greater with our own single-loading rifle than when they are placed in the rifle five at a time in a clip which drops out when the last one has been fired, or when they are swept into the magazine out of a charger that has a clip which does not enter the magazine, but is thrown away before the first cartridge is used. It used to be thought that a man who would put five cartridges into his magazine and fire two or three of them would throw away the remainder in order to put in a new clipful, and to feel that he had a full number of cartridges in reserve. But there is probably not very much in this contention, for it would seem as if the leakage, when cartridges are carried singly, must be so much greater than the loss of them when carried in clips holding several, under all the circumstances of active service, as to neutralise any advantage in carrying them singly. Certainly packets of ammunition of a substantial size which can be put straight into the magazine are much less likely to be dropped by flurried fingers than single cartridges. The comparative advantages of a magazine that can be filled with loose cartridges as against one suited to loading from clips or chargers are worthy of the most careful and patient experiment. It is unfortunate that cartridges in clips or chargers require more packing space than when they are laid head and tail alternately, as in the packets to which the British Army is accustomed.

It may be observed that with a rifle specially adapted for single loading there is some advantage in having the base of the chamber exposed to view when the bolt is withdrawn, especially for cleaning purposes. In such rifles as the Mannlicher, where the head of the bolt enters into the sleeve behind the barrel, which is long enough to give space for the lugs on the bolt head to engage immediately behind the chamber, the insertion of single cartridges is more troublesome than with our own rifle, because there is no 'cut off,' but in loading from the magazine there does not seem to be any real disadvantage in this arrangement, although the bearings for the lugs are less accessible for cleaning.

With regard to the general question of what is the most practical method of fire for the soldier, it will be seen to be a most important thing, if possible, to have to teach only one method of loading or firing the rifle. If this be done, an almost mechanical exactitude of manipulation and obedience to the word of command is much more easily acquired than if there is an attempt to teach two systems. It is far more practicable for the commander to obtain a complete fire control if the soldier does not have to be taught sometimes to load a single cartridge, and sometimes to fill the magazine and load from it. In the change and variety of words of command, and of the actions to which they refer, there is confusion and there is flurry. If the loading is always from clips or chargers, and the shots are always fired from the magazine, the manipulation becomes so entirely mechanical that it can hardly go wrong, and the only necessary distinction would seem to be that between slow fire, either continued at a given rate or with the number of rounds to be expended named, and rapid fire to be poured in unceasingly until it is stopped by word of command.

The same reasoning applies to volley firing, upon which in the British army so much time and trouble has been expended. It was a method of collective firing which had some excellent points in the days of black powder and close-order formations of two ranks. The man who did not fire simultaneously with those on each side of him had his field of vision entirely obscured by the smoke from their rifles, and must either hold his fire or discharge at random. Nor was exactitude of aim of great importance when you could wait until you saw the whites of their eyes as the enemy advanced, for the mark was a large one. In these circumstances the physical effect of the volley was crushing, and its moral effect, especially when it was instantly followed by a charge with the bayonet, made it irresistible. In the last thirty years the case has altered. Smokeless powder has entirely removed the necessity for simultaneous fire. Long ranges have deprived it both of its moral and physical effectiveness. The man who is ordered to fire at a given instant must often lose something of his accuracy and aim. A Pathan crouching behind a rock and hearing the rattle of a volley on the stones round him knows that he has a few seconds in which he can show himself and deliver his shot in perfect safety. And, finally, the inevitable use of extended order against foes armed with modern weapons has made volley firing almost impossible, since, with men ten or twenty paces (or even further) apart, no commander can exercise an effective control over every shot fired even by a small body of men. Although the volley can be used at extreme ranges when it is not necessary to open the line of men to intervals, yet such occasions must be so rare, and the advantage in such circumstances so small, as not to compensate for the trouble of learning an otherwise unnecessary exercise. If, as seems certain, in the battles of the future from 90 to 95 per cent. of the firing must be independent, is it worth while to teach two systems of fire? at least, would it not be better to concentrate attention on that one which is indispensable? So far as we have heard, the control of independent fire has in the Boer War been found much less difficult than was expected. Men fighting in scattered formations soon realise how vital it is to husband every round. The long distances of present-day fighting tell against panic and the unthinking waste of cartridges.

The developement of the drill book and the firing exercises has mainly consisted in cutting away unnecessary complications since the time (three hundred years ago) when almost every mathematical permutation and combination of figures was exhausted in the complicated countermarchings, turnings, and formations which were then considered necessary to the art of a soldier. This process of cutting away all that is not essential is being continued with advantage at the present day.

CHAPTER V

EARLY SPORTING RIFLES—SIR SAMUEL BAKER'S RIFLES—CAPT. FORSYTH'S VIEWS—THE EXPRESS RIFLE—THE 'FIELD' TRIALS, 1883—THE REDUCTION OF CALIBRE—PENETRATION AND EXPANSION OF MODERN RIFLES—ACCURACY—TRAJECTORY TABLES—SINGLE AND DOUBLE RIFLES—BALL AND SHOT GUNS—ROOK AND GALLERY RIFLES—CLUB RIFLES—THE MORRIS TUBE—ADAPTORS FOR MILITARY RIFLES

The developement of sporting rifles, beginning, as we have seen, earlier than that of military rifles, has, nevertheless, in later times, followed that of military arms. It may almost be said that the history of the latter is the history of the former. The fact that the fouling was so great a cause of difficulty in firing a series of shots in a short time with the rifle was of far less importance when it was used for sporting purposes than as a soldier's weapon. We have seen that Alonso de Espinar says that tightly fitting bullets, driven by force into the grooving, and fired without the wadding soaked in pitch, which he recommends, cannot be got into the barrel for two shots running on account of the fouling, and that the barrel has to be washed before loading again. He seems to have done something in his day towards solving the problem by using a wadding of the proper kind.

Certainly the earliest rifled arms with which we are acquainted are sporting arms, and not military, and weak as were the charges and short the distances at which game was killed in early days, the improved accuracy of the rifle was certainly appreciated. We may take it that the Continental rifles used in Switzerland and the Tyrol in the eighteenth century existed primarily as sporting weapons. It would naturally be in shooting chamois, roe-deer, or larger game that the advantage in range given by the rifle over the smooth-bore would most clearly appear. We have already said something of these Continental rifles, and also of the rifles used in the American war early in the eighteenth century. These were made primarily for the backwoodsman's use. The Kentucky pea-rifle, really a generic term for the rifles of small calibre used by the American hunters, carried a very small round ball (for lead was very scarce, and the hunter had to make his own bullets), propelled by a charge of powder not very large, for powder also had to be economised, yet ample to give the ball considerable velocity. It is clear that for dangerous game, such as bears, these rifles lacked power, whence probably arose the terrible reputation of the grizzly bear; but their accuracy was admirable, even if it was not quite up to the standard of the heroic feats recorded in Fenimore Cooper's novels. Colonel Hanger speaks of the American rifle used in the war as having carried a ball of thirty-six to the pound, that is, it was a half-inch bore—very small compared with the musket. But the real pea-rifle was of a very much smaller bore than this. One which formerly belonged to Sir Henry Halford, and is in the possession of the writer, with a barrel 45½ inches long, has a calibre of only ·390. Greener speaks of the American rifles as being in some cases as small as 90-bore, *i.e.*, about ·370 bore.

The rifles used even for dangerous game in India, and in Africa, were up to the middle of the nineteenth century what we should now call very feeble weapons. The normal weapon seems to have been generally of from 12- to 16-bore, firing a spherical bullet of an ounce or so. The distances at which such rifles were effective were not great, the velocity being very moderate, and the striking power rapidly lost in flight. The smooth-bore, in fact, held its own very fairly for all sorts of jungle-shooting until quite modern times. Very accurate shooting could be obtained from small-bore rifles made to fire light charges for rook-shooting and the like; these were effective at no very great distance, for the trajectory was very curved. There seems to have been almost no attempt to produce a rifle of large bore and smashing power until, in 1840, Sir Samuel Baker, having had experience in the East with the want of effect of the ordinary rifles upon big and dangerous game, designed a large and heavy rifle, which he afterwards used with great success. This rifle is described by Mr. Greener in 'The Gun and its Development.'

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It weighed 21 lb., and fired a charge of 16 drachms, with a round bullet 3 oz. in weight; it was nearly an inch in calibre, and it had two broad grooves, making one turn in the length of the barrel. This rifle was made by Gibbs, of Bristol. Sir Samuel Baker afterwards used with success a double-barrelled 10-bore (·770 inch) rifle made on the same principle. These heavy rifles furnished a type for the elephant rifles of 4-bore and 8-bore so frequently used afterwards.

An interesting picture of the condition of the sporting rifle in 1863 is given in Captain Forsyth's book, 'The Sporting Rifle and its Projectiles.' Writing as a sportsman of large Indian experience, he distinguishes two classes of rifles, the deer rifle, which is carried by the sportsman himself, and the heavy rifle for dangerous game, to be carried by a gun bearer. He distinguishes the requirements of the sporting rifle, as against the military rifle, in its not being used at long ranges. He adds that the sporting rifle should give not merely a penetrating but a disabling wound; and he draws attention to the importance, where penetration is equal, of having a projectile which should have a large striking surface; he would therefore use the largest bore of rifle consistent with the limitations of its weight. The rifle must be accurate up to 150 (Sir Samuel Baker says 200) yards, for practically all shots in jungle-shooting are within 100 yards. The trajectory must be as flat as possible. He cites the Kentucky rifle as an ideal in this respect. He considers 9 lb. as about the limit of weight for a rifle to be carried by the shooter; the recoil must not be excessive, and the barrels must be short and handy. In dealing with the question of the bullet he agrees with Sir Samuel Baker that its anterior surface must not be sharper than a hemisphere, as the effect of the bullet should be rather in the nature of a blow than a penetrating thrust. His conclusion is that a rifle taking a spherical ball should be used with a large charge of powder. The spiral for a barrel of 14-bore he puts, as previously mentioned, at one turn in 8 feet 8 inches, the grooves being very shallow and broad, and the bullet wrapped in a patch. With such a rifle firing its ordinary load he makes the height of the 100 yards trajectory to be as little as

2½ inches at 50 yards. He does not say what the normal charge was, nor does he define the term 'point-blank,' which he uses when he says that 'the point-blank of this rifle with 3 drachms is about 60 yards; with 4 drachms, about 85 yards; with 5 drachms, 100 yards.' His objection to the use of conical bullets is that they either penetrate too much, or, if made expansive, open without sufficient penetration; and that the velocities which General Jacob obtained from them are insufficient to deal with heavy game. The best of the rifles of that time which fired conical bullets he considers to be Purdey's two-grooved rifle, with one turn in 6 feet of barrel, which was accurate, but would not kill on the spot anything larger than wild antelope or bustard. He makes his comparisons, however, by comparing rifles of the same bore, carrying spherical bullets, against those carrying conical, and consequently finds that within the limits of the weight of the rifles the former have the advantage in velocity, and therefore in trajectory at sporting ranges. He does not consider, as we should at the present day, the total striking effect of the bullets, and the problem of regulating a conical bullet to give the precise amount of penetration and expansion required was far from being solved.

Captain Forsyth was not alone in his views. Mr. Greener says in his book, 'Gunnery in 1858,' that for other purposes than war rifles will continue to be constructed on the polygroove principle, and with spherical bullets. He adds that small-bore elongated bullets were very rapidly adopted for sporting purposes, and as rapidly abandoned, because they did not 'kill dead.' It is proverbially dangerous to prophesy, and Mr. Greener was not fortunate in some of his predictions. His forecast that 'for close quarters, line-firing, or quickness of loading the musket will hold its place for centuries to come' has by no means been justified by the event.

Sir Samuel Baker found, naturally enough, that with his very heavy two-grooved rifle a spherical 3-oz. bullet would stop a charging elephant, but says that a 4-oz. conical bullet quite destroyed the effect of this rifle. The spherical ball was certainly effective enough, and so the change was unnecessary. About this time the ingenuity of gunmakers was exercised upon producing effective rifles carrying cylindro-conical bullets. The two-grooved rifle was the favourite form. Greener made at that time what he called a Cape rifle of 40 or 52 calibre, ·500 or ·450, and other gunmakers were on the same track. Purdey's rifles of the same kind and similar calibre were very successful. These rifles followed the lead of the American rifles of which we have spoken, in laying special stress on the velocity obtained, and in 1856 he gave them the name of 'Express train' rifles; hence the term 'Express,' which has been used to define sporting rifles of a certain kind down to the present time. It only required careful experiments by gunmakers, who realised the importance of combining sufficient striking power, a proper degree of expansion in the bullet, and the flattest possible trajectory, to put the spherical bullet out of court altogether. The essence of the Express rifle is in the points just mentioned.

Mr. Walsh's admirable book on 'The Modern Sportsman's Gun and Rifle' shows some kind of consensus of opinion that the velocity of an Express rifle should be not less than 1,600 feet; and Mr. Walsh's own definition, in which some gunmakers agreed, was that the velocity should be not less than 1,750 feet, which he considered to give a trajectory such that the bullet rises not more than 4½ inches in the course of a flight of 150 yards when correctly sighted. This was certainly, in 1884, when his book was published, the furthest distance which could fairly be used in stalking, if we may exclude the occasional long fluky shot, which figures from time to time in most sportsmen's records, and is so frequently regretted. The same opinion is expressed by Van Dyke, in his excellent book, 'The Still Hunter,' published in New York in the previous year. His view is that 150 yards is the furthest fair sporting distance, and that, if possible, one should get a great deal nearer than this. Up to half a dozen years ago, in fact, a shot at 120 yards was rather a long shot, and the bulk of shots in stalking were taken very much within that distance.

The Express rifle quickly revolutionised deer-stalking. The rifle of old days, whether a Purdey two-grooved rifle, carrying a belted ball, or one of the older poly-grooved rifles, with a large round bullet and a comparatively small charge, had never made certain work. The delightful and exciting episodes described in Scrope's book on deer-stalking, and in other writings of the same period, depend largely upon the use of the deerhound as an auxiliary to the rifle. Landseer tells us pictorially the same story. The chase after a wounded hart, to be singled out skilfully from his companions by the fleet hound, to be chased relentlessly until he turned to bay, probably in some rocky pool of a rapid burn, there to be dispatched by a well-timed shot at close quarters, or by the knife of the daring hunter; the brave dog, gashed or seriously maimed by a stroke of the horn; these picturesque and exciting elements have almost disappeared from the sport. The chase of the quarry which has been shot at, so far from being inevitable, has become quite exceptional. The improvement in rifles, which brought about the deadliness of the shot, has made an ill-placed bullet, followed by a long hunt, everywhere a lamentable accident, and on some forests a positive disgrace to the shooter.

Is deer-stalking the poorer for this? Surely not. It is at least more merciful than it used to be. The delight of the wild scenery, the exhilaration of bodily exercise in pure air, and the ever-varying circumstances of wild country and majestic scenery; the inspiring sense of solitude, broken only by the whistle of the curlew or the croak of the raven; the intimate communing with Nature in every aspect of sunshine, mist, and storm—all these remain, and with them the satisfying of that hunter's instinct which is one of the most deeply-rooted things in human nature, the delight of pitting the human intellect and the human senses against the trained instincts of self-preservation of a really wild animal.

But this change in the aspect of a noble British sport will hardly compare in importance with the effect which powerful, high-velocity rifles have had in altering the conditions of sport on other continents. The dangerous reputation of the grizzly bear, savage and enormously powerful as he is, has been largely discounted by the more destructive weapons of modern days. There is danger enough even now from the tiger, the buffalo, or the charging elephant, especially when wounded, but the odds are far more heavily against the animal with the rifles of almost unlimited power now made in a comparatively handy form, and effective at comparatively long distances. Anyone who has read that delightful book by Colonel Walter Campbell, 'The Old Forest Ranger,' or who is familiar with the literature of sport in India or in Africa fifty years ago, and studies also that of to-day, will realise the immense difference in the character of modern sport; and it is certain that the comparison will in no wise detract from his high opinion of the pluck and daring of our forefathers. Besides the greater power of improved rifles, the invention of breech-loading has multiplied manyfold the advantage enjoyed by more modern sportsmen.

It will be interesting to record here something of the capabilities of the Express rifles of twenty years ago. We have mentioned the qualities as regards velocity which the Express rifle of that time possessed. The account given by Mr. Walsh in the second volume of 'The Modern Sportsman's Gun and Rifle,' of the 'Field' trials, held in 1883 at Putney, show authoritatively how good was the accuracy, and how admirable the velocity, attained at that time. The smallest calibre of Express rifle used was the ·400, a bore which was at that time too small to be popular, though for deer-stalking nothing better existed. The Express rifles of ·450 and ·500 bore, which were much more commonly used, were shot in the 'Field' trials at the same time. We will quote the velocities and particulars of the trajectories of these rifles in the order in which they are given by Mr. Walsh, taking for particular examples Messrs. Holland & Holland's rifles, which were the winning rifles in the trials in all three classes.

To arrive at the trajectories, the position of each shot was very carefully recorded at different distances by firing through a series of light paper screens, very exactly levelled. The trajectories were also calculated by Major McClintock, of the Royal Small Arms Factory. The flight of the bullets thus calculated from trials with the chronograph seems to have shown a curve slightly more regular, and a little lower at its highest point, than that of the observed diagrams. The probability is that the actual diagrams give a closer approximation to the real form of the curve described by the bullet than the calculations.

If we take the curve of the ·400 in a flight of 150 yards, we find that its height above the zero-line joining the muzzle of the rifle to the point struck by the bullet was as follows :—

At 25	50	75	80[1]	100	125 yds.
2·52	3·12	4·35	4·45	3·28	2·28 in.

The initial velocity of this rifle was 1,874 feet per second; it was double barrelled, and weighed 7 lb. 14 oz.; the charge of powder was 3 drachms (82 grains); and the bullet weighed only 219 grains. The accuracy obtained was admirable, the average deviation of ten shots, fired five from each barrel, being only 3·23 inches at 150 yards.

The winning ·450 rifle, also made by Messrs. Holland & Holland, weighed 8 lb. 4 oz., and fired 110 grains of powder and a bullet of 328 grains. The trajectory was as follows :—

At 25	50	75	80[1]	100	125 yds.
2·03	3·33	4·65	4·68	3·55	2·45 in.

The average deviation of five shots from each barrel with this rifle was 1·45 inch—a very remarkable performance.

The winning rifle in the class for ·500 double rifles was again Messrs. Hollands'. Although at 150 yards its performance was very slightly inferior to that of Messrs. Adams', on the whole three ranges it was the more accurate. It weighed 9 lb. 1 oz., and fired 138 grains of powder and a bullet of 435 grains. The trajectory was as follows :—

At 25	50	75	80[1]	100	125 yds.
2·12	3·43	4·72	4·82	3·63	2·47 in.

As to its accuracy, the average deviation of five shots from each barrel was 2·9 inches, that of the Adams rifle at the same distance being 2·4 inches.

It is very noticeable in the shooting of these rifles, of which full particulars are given by Mr. Walsh, that the accuracy with Messrs. Hollands' rifles was in almost every case superior in proportion at 150 yards to that at 50 and

[1] Eighty yards is inserted as being approximately the culminating point of the trajectory.

100 yards. The tendency of Express rifles at this time was towards lightening the bullet almost too much in order to obtain high velocity. Complaints have been made, and even the reputation of Express rifles as a class has suffered, because men have had experience of bullets which absolutely broke up, as it were, on the surface of an animal on striking a bone, and did not penetrate to the vital parts. This is more particularly liable to happen with such heavy animals as sambur or tiger, for which more penetration is required than for the stag of these islands. It is noticeable that in the 'Field' trials all the Holland rifles, which took the first place, fired bullets rather heavier than those of the other rifles entered in the same classes. It would seem that not only does effective killing power suffer from too light a bullet, especially as the range increases (for a light bullet loses its velocity far more quickly than a heavy one), but that a positive loss in accuracy takes place when the bullet is lightened beyond a certain point. Where bullets are made very light in proportion to the calibre of the rifle, not only do they have to be made with a large cavity, but they are often liable to be deformed by the explosion. They also become so short that there is some risk of the bullet being a little tilted and not delivered true from the barrel, after the fashion already shown in figs. 9 and 10, p. 39.

Figs. 44 and 45 show, in section, Express bullets of the ·500 and ·450 bores, weighing 410 and 350 grains respectively. These are more effective projectiles than the standard sizes weighing 340 and 270 grains. We illustrate also (figs. 46 and 47) the complete cartridges for the best known of the Express rifles, the ·500 and ·450, with bottle-shaped case.

We will now pass to the trial of rather heavier rifles, and those specially suited for large game. The Express rifle of ·577 bore, limited to a weight of 12 lb., comes distinctly into this class. Six rifles of this kind were entered in the 'Field' trials by different gunmakers, and again Hollands' rifle took the first place. At 150 yards the average deviation of five shots from each barrel was 2·42 inches; the charge was 164 grains of powder, the bullet weighed 591 grains, and the average velocity was 1,663 feet per second. The trajectory for 150 yards, as shown on the screens, was as follows:—

At 25	50	75	80[1]	100	125 yds.
1·92	3·44	4·84	4·86	3·72	2·68 in.

This rifle, then, with its rather lower velocity, still had a trajectory less than 5 inches in height at this distance.

We may now compare the striking energies of these rifles at the muzzle and at 150 yards, as calculated by Major

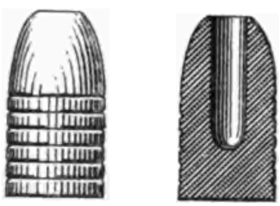


FIG. 44

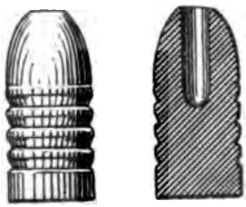


FIG. 45

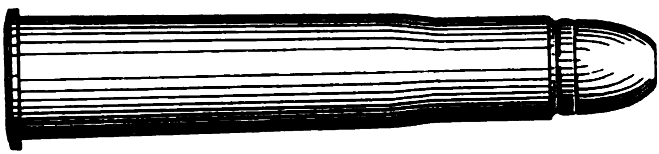


FIG. 46

FIG. 47

McClintock, for, after all, it is the striking power which is effective rather than the energy developed at the muzzle. The striking energy depends even more on the velocity than it does on the weight of the bullet. With bullets of different weights, moving at the same speed, it will vary directly as the weights of the bullets; but if two bullets of the same weight strike an object with different velocities, the variation in the effect is not directly proportional to the

[1] Eighty yards is inserted as being approximately the culminating point of the trajectory.

velocities, but varies as their squares. By increased velocity, then, striking power can be obtained almost disproportionate to that which a change of weight in the bullet will give, as the following table shows:—

Bore	Bullet	At Muzzle		At 150 Yards	
		Velocity	Striking Energy	Remaining Velocity	Striking Energy
	grs.	f. s.	ft. lb.	f. s.	ft. lb.
·400	209	1,874	1,628	1,326	815
·450	322	1,777	2,254	1,335	1,274
·500	444	1,784	3,134	1,382	1,939
·577	591	1,663	3,625	1,286	2,169

From this table it will be seen that the ·400 rifle lost half its original striking energy in the 150 yards flight, though losing only one-third of its velocity, and that all the rifles lost more than one-third of their striking power in the same distance, though maintaining a much larger proportion of their velocity and, of course, all their original weight.

The still heavier rifles, to which we now come, give very considerable striking energy, with greater penetration than the hollow bullet of the Express rifle, with which we have been dealing. These rifles, the successors of Sir Samuel Baker's heavy rifle already mentioned, were tried for velocity both with spherical and conical bullets, and the calculations by Major McClintock of the energies and remaining velocities gave the following results:—

Bullet		At Muzzle		At 150 Yards	
		Velocity	Striking Energy	Remaining Velocity	Striking Energy
		f. s.	ft. lb.	f. s.	ft. lb.
8-bore, about ·835 in.	*Conical* 1,257 grs.	1,500	6,273	1,178	3,870
	Spherical 862 grs.	1,654	5,232	1,038	2,069
4-bore, about 1·05 in.	*Conical* 1,882 grs.	1,330	7,387	1,091	4,969
	Spherical 1,250 grs.	1,460	5,912	981	2,869

The 8-bore rifle weighed 16¼ lb., and fired a powder charge of 233 grains. The 4-bore rifle weighed 20 lb., and fired a powder charge of 328 grains. The velocities were arrived at from chronograph observations, and the height of the trajectories, &c., calculated from the same. There are some interesting points which come out in connection with these tables, as they enable us to compare spherical and conical bullets of the same calibre. Taking first the 8-bore rifle, we see that with a conical bullet it lost 322 f.s. of velocity, whereas the spherical ball lost 616 f.s. The loss of velocity is, of course, greater at high speeds than at low, and with bullets of the same shape a velocity of 1,654 f.s. would fall off more quickly than one of 1,500 f.s., other conditions being alike; but in the present case the falling off with the round bullet of equal penetrating surface, but not much more than two-thirds of the weight of the conical bullet, is so great that, starting with an advantage of 154 f.s. its velocity is reduced to 140 f.s. below that of the other at the same distance. In striking energy the difference is even more apparent. Similarly with the 4-bore, the spherical bullet starts with 130 f.s. more velocity, but ends with 110 f.s. less.

Here we get some slight indication of the immense gain in maintenance of velocity and striking energy given by the conical bullet. With it the great power of these heavy rifles stands out in contrast even with that of the powerful Express rifles which we have been considering. Taking the conical bullets, we see that the power of the 4-bore is double that of the ·577, itself a very smashing rifle, while that of the 8-bore is double that of the ·500. Small wonder that a charging elephant can be stopped or turned with such weapons as these; and small wonder, too, that occasionally the hunter finds himself unexpectedly recumbent from the effect of the recoil after a hasty shot.

It is a curious fact that the effects of recoil are so little noticeable when firing actually at game, whether with the rifle or a shot gun. The recoil, which even with the 12-bore shot gun is so marked when shooting at the target as to be apt to bruise the shoulder and possibly to cause flinching, will commonly be taken up with perfect ease by the muscles of the shoulder in actual shooting; and even large-bore rifles are far more capable of being used without material inconvenience to the sportsman than might be supposed.

While the great stopping power to which we have alluded is so necessary under certain circumstances with dangerous game, it is very possible to do good work with the ordinary Express rifle. To kill elephants, as Mr. Sélous has done again and again in Africa, with the single Express rifle of ·450 bore, rifled on the Metford system, and carrying a solid bullet and charge such as were used for match shooting at long range, must require an amount of coolness, of nerve, and, it may be added, of experience, which it can fall to the lot of very few mortals to acquire. In such conditions the bullet must be planted in exactly the right place. Although elephants can be, and have been, killed with the ·303, the novice is not recommended to attempt the feat.

We have spoken of the progress shown in the developement of the Express rifle, which had in comparatively few years substituted a safe, rapid, and convenient breech-loader for the old muzzle-loaders, that, good as they were, had in their degree serious drawbacks, not the least being the increased chance of a missfire at a critical moment owing to damp or rain. But another developement almost as important was at hand, of which we seem even as yet hardly to see the end. In connection with military rifles, we have mentioned the application to them of smokeless powder, and the reduction in calibre, and in the weight and size of the cartridge, without anything like a proportionate loss of power, which have now come about. The sporting rifle, which has in its later history followed rather than led the improvements in the soldier's weapon, has now similarly changed its character. When the introduction of the Lee-Metford was first decided upon, it was maintained in debate, even in so enlightened a place as the House of Commons, that an arm of so small a calibre could not possibly be an effective killing weapon. The same idea, that excellent conservative love for things that we know and can trust, has made the general adoption of small-calibre rifles for deer-stalking a very gradual process; their accuracy, however, is unmistakable, and their killing power ample.

A chief feature of these rifles, humane, indeed, in war, but less satisfactory in sport, is that with a hard bullet the penetration is very great. It may be judged from the following table of thicknesses of material which are usually necessary to stop the regulation ·303 inch bullet:—

Material	Proof at any range in inches
Sand	20
Earth, free from stones (not rammed)	28
Peat earth	60
Clay (penetration depends on amount of moisture in it)	48
Good brickwork	9
Fir	48
Elm	33
Teak	36
Oak	27
Wrought iron or mild steel plate	$\frac{7}{16}$
Hardened steel plate	$\frac{1}{4}$
Shingle between boards	4

The bullets find their way through joints of walls unless made very fine and set in cement. About 150 rounds, concentrated on nearly the same spot at 200 yards, will breach a 9-inch brick wall, and about 800 rounds at the same range will breach a 14-inch brick wall. The penetration into green timber is practically the same as into dry, hence trees and logs afford but poor protection. Stockades, to be of any use, should contain a core of shingle, brick, sand, or macadam from roads. Rammed earth gives less protection than loose. Sandbags and cartridge boxes filled with earth or clay cannot be depended upon unless banked up with earth.

In striking an animal the bullet is not necessarily deformed even against bone, and therefore penetrates, making a very small hole, and causing little injury unless it strikes the spine or the heart, or one of the large blood-vessels. This had been so clearly shown in recent years in South America, in Chitral, and in the Turco-Greek war, that it should not have come as a surprise to us in the Boer war. In South Africa we have had endless examples of the most wonderful recoveries from wounds which, if they had been made with the old rifles of large bore and leaden bullets, must have been fatal. The penetration of the abdomen, the thorax, and even of the brain, has in some cases caused almost nothing beyond a little temporary inconvenience. It has been stated on very high authority that more than one case has occurred where the actual muscular part of the heart has been perforated without fatal results. Yet take this same bullet, and weaken the hard metal thimble of it at or near the nose, either by filing it away at the point so as just to expose the lead, or by slitting the fore part of it at the side, or in some similar fashion, and a remarkable change will be found. A stag struck by such a bullet in the right place seems paralysed, as the bullets of the older rifles could not paralyse him. If struck 'too far back,' instead of going a long distance, and, perhaps, getting clear away, he seems incapable of any exertion, and this whether the rifle used is the ·303, with a bullet of about 215 grains, or the ·256, the bullet of which weighs only 156 to 160 grains. We give an illustration (fig. 48) of the solid military bullet used with the ·303 rifle. The envelope in these is unbroken except at the base, and is a good deal thicker at the nose than further back. The cannelure, or groove near the base, serves to give the cartridge a hold upon it, three nicks being impressed into the case at the neck, which engage in it and prevent the bullet dropping out or being pressed further than it should into the cartridge. The Dum-dum bullet (fig. 49) has a very similar envelope, but the core is exposed at the nose, so that it naturally 'mushrooms' and breaks up upon striking any substance that resists it. Fig. 50 shows the Mark IV. bullet, which has a hollow in the nose, at the base of which is a small coned disc of cupro-nickel. The principle on which the hollow nose is substituted for the method of simply exposing the lead point is ingenious. It is found that with a hollow-fronted bullet of moderately hard composition there is considerable penetration into wood or any dry sub-

FIG. 48

FIG. 49

FIG. 50

stance without the bullet being shattered, but if any substance containing a large amount of liquid be struck, then a hydraulic pressure is set up within the hollow which causes the bullet to open at the nose and expand considerably. Consequently in animal tissues the bullet will inflict considerable damage. That the expanding effect depends almost entirely upon the presence or absence of moisture has been completely shown in a series of experiments upon clay containing different percentages of water. The two bullets illustrated (figs. 51 and 52) are bullets of ·450 bore fired from a high velocity rifle and cut out from the carcase of a rhinoceros. They are good examples of the mushroom shape into which a completely sheathed bullet will open in meeting heavy resistance from animal tissues. We have seen cases in which the little bullet of the ·256 Mannlicher taken from the body of a stag has been found to have opened to almost as large a disc as the bullets here shown.

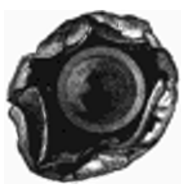


FIG. 51

FIG. 52

The absence of smoke from the explosion is all against the quarry. The power of rapid reloading given by the magazine action tells also heavily against him, and, curiously enough, even the admirable accuracy of the Express rifle is surpassed by these rifles of more than express speed. The records of the Martin Smith competition at Wimbledon and Bisley, a competition shot at 100 yards at a target 1 foot in diameter, with a bullseye of 2 inches, show clearly how extremely accurate the little rifles are at such distances. We reproduce by permission a diagram (fig. 53) of five shots at 100 yards made by Mr. St. George Littledale with a ·256 Mannlicher rifle, a similar weapon to that which had accompanied him almost to Lhassa in the previous year, and had constantly supplied his whole caravan with meat.

Diagrams of this class can never be held to represent the normal accuracy of a rifle. On the other hand, it is impossible to make them without excellent qualities both in the

FIG. 53

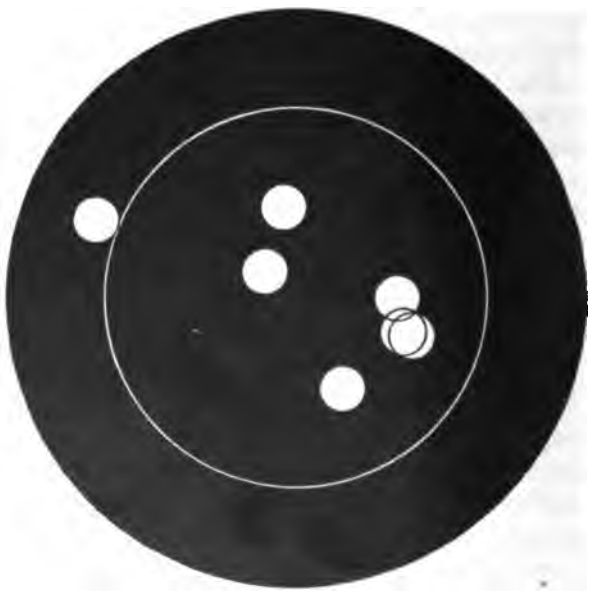


FIG. 54

rifle and in the man, as well as that 'turn of the luck' which so often crowns skill with success.

We reproduce also (fig. 54) the first full score ever made at a similar target in the Martin Smith competition at Bisley (1900) with all seven shots in or touching the central 2-inch circle. This was also made with the ·256 Mannlicher, and is an exceptionally fortunate score, as the first shot only grazed the edge of the 2-inch ring, and the remaining six shots, fired with a change of aim, fortunately grouped themselves well within it. It is somewhat noticeable that the ·303 fails, as a rule, to do so well at 100 yards as the ·256. With the latter rifle, if ten shots are fired with the same aim, and all goes reasonably well, nine shots out of the ten can usually be brought within or touching a 2-inch circle, drawn so as to include the greatest possible number of shots.

The trajectories of these rifles up to 200 yards are as superior to those of the Express rifles as theirs were to their predecessors. We append a table of the trajectory and fall up to 500 yards of the bullets of the ·256 and ·303 rifles, as containing much information useful to the sportsman who uses them. The figures in ordinary type read downwards show the height of the bullet above the line of sight when aimed for any particular distance. Those in *italics* show the amount of the bullet's fall after passing the distance for which it is aimed. Thus, if we take 200 yards in the top line, the figures below this show that the ·303 bullet, when fired with the elevation for 200 yards, rises to 3·9 inches at 50 yards, 5·5 inches at 100 yards, and to 4·3 inches at 150 yards. At 200 yards it is assumed to strike true, at 300 yards it has fallen 1 foot 7·3 inches below the line of aim; at 400 yards, 4 feet 7·3 inches; and so on. From this table may be readily seen what would be the amount of the error in elevation introduced by a miscalculation of distance of 50 or 100 yards. The table for the ·256 rifle is exactly similar, but, owing to its flatter trajectory, the quantities dealt with are smaller. When out stalking, the writer has found it convenient to carry in the pocket for reference a card with these tables printed on it.

It should be noted that in these tables no allowance has been made for the height of the foresight above the bore, which slightly affects the relation of the fall of the bullet to the line of aim, though not appreciably at anything like a long distance. The tables assume that the line of aim crosses the centre of the axis of the barrel at the muzzle, and, in fact, leaves the rifle exactly from the same point as the bullet. This is not the case, but the error introduced is for practical purposes very trifling.

·303 Rifle, 215 gr. Bullet, muzzle velocity 2,000 f.s.

Elevation given for	0	50	100	150	200	250	300	350	400	450	500
Height of Bullet at	ft. in.	ft. in.	ft. in.	ft. in.	ft. in.	ft. in.	ft. in.	ft. in.	ft. in.	ft. in.	ft. in.
50	*1·1*	—	1·2	2·5	3·9	5·5	7·2	9·0	10·9	1 ·9	1 3·0
100	*4 6*	*2·4*	—	2·6	5·5	8·6	11·9	1 3·5	1 7·3	1 11·4	2 3·6
150	*10·9*	*7·5*	*3·9*	—	4·3	9·0	1 2·0	1 7·3	2 –	2 7·1	3 1·5
200	*1 8·2*	*1 3·8*	*11·0*	*5·7*	—	6·2	1 ·9	1 8·0	2 3·6	2 11·7	3 8·3
250	*2 9·0*	*2 3·5*	*1 9·5*	*1 2·9*	*7·8*	—	8·3	1 5·3	2 2·8	3 ·9	3 11·6
300	*4 1·7*	*3 7·0*	*2 11·8*	*2 3·9*	*1 7·3*	*10·0*	—	10·7	1 10·1	2 10·3	3 11·1
350	*5 10·4*	*5 2·7*	*4 6·3*	*3 9·1*	*2 11·0*	*2 ·2*	*1 ·5*	—	1 1·3	2 8·5	3 6·5
400	*7 11·7*	*7 2·8*	*6 5·3*	*5 6·7*	*4 7·3*	*3 6·9*	*2 5·5*	*1 3·2*	—	1 4·2	2 9·3
450	*10 5·9*	*9 7·9*	*8 9·1*	*7 9·3*	*6 8·4*	*5 6·4*	*4 3·4*	*2 11·3*	*1 6·2*	—	1 7·3
500	*13 5·3*	*12 6·2*	*11 6·2*	*10 5·1*	*9 2·7*	*7 11·2*	*6 6·5*	*5 ·7*	*3 5·6*	*1 9·4*	—
Angle used		2'·1225	4'·41	6'·9225	9'·66	12'·6225	15'·81	19'·2225	22'·86	26'·7225	30'·81

·256 Rifle, 156 gr. Bullet, muzzle velocity 2,350 f.s.

Elevation given for	0	50	100	150	200	250	300	350	400	450	500
Height of Bullet at	ft. in.	ft. in.	ft. in.	ft. in.	ft. in.	ft. in.	ft. in.	ft. in.	ft. in.	ft. in.	ft. in.
50	*·8*	—	·9	1·9	3·0	4·2	5·5	6·9	8·4	10·1	11·8
100	*3·5*	*1·8*	—	2·0	4·2	6·6	9·2	1 –	1 3·1	1 6·3	1 9·8
150	*8·2*	*5·7*	*3·0*	—	3·3	6·9	10·8	1 3·1	1 7·6	2 ·5	2 5·7
200	*1 3·3*	*11·9*	*8·4*	*4·4*	—	4·8	10·1	1 3·7	1 9·6	2 4·3	2 11·2
250	*2 1·1*	*1 8·9*	*1 4·5*	*11·5*	*6·0*	—	6·5	1 1·6	1 9·2	2 5·3	3 2·0
300	*3 2·0*	*2 9·0*	*2 3·6*	*1 9·7*	*1 3·1*	*7·9*	—	8·5	1 5·6	2 3·3	3 1·7
350	*4 6·2*	*4 0·4*	*3 6·1*	*2 11·2*	*2 3·5*	*1 7·1*	*9·9*	—	10·6	1 10·0	2 10·1
400	*6 2·1*	*5 7·4*	*5 ·3*	*4 4·3*	*3 7·6*	*2 9·9*	*1 11·5*	*1 ·1*	—	1 1·0	2 2·8
450	*8 2·0*	*7 6·5*	*6 10·5*	*6 1·5*	*5 3·6*	*4 4·8*	*3 5·0*	*2 4·3*	*1 2·6*	—	1 3·5
500	*10 6·2*	*9 9·8*	*9 ·9*	*8 2·9*	*7 3·9*	*6 3·9*	*5 2·8*	*4 ·7*	*2 9·5*	*1 5·3*	—
Angle used		1'·6	3'·3	5'·2	7'·3	9'·6	12'·1	14'·8	17'·7	20'·8	24'·1

TRAJECTORY TABLES

Of ·303 and ·256 Rifles, to 500 yards, showing the height of the bullet above or below the line of aim when elevation is given for any even distance of 50 yards.

The measurements are given to the nearest $\frac{1}{10}$th of an inch. Those in *italics* are minus quantities, *i.e.* the bullet is below the line of aim. N.B.—No allowance has been made for height of foresight above centre of bore.

It may be estimated from these trajectories what great advantage is gained with rifles of such high velocity in firing at game within sporting range at distances which have to be guessed. Especially for shooting such game as chamois, black buck, and antelope of all kinds, where the mark is small, and the margin which can be allowed for the drop of the bullet without missing the shot very limited, these rifles are found excellent. It is the common experience of those who have used them, whether the ·303, ·256, or the Mauser ·275, that the distance at which they can kill game has been increased by 50 to 70 yards. In a drive the writer has himself seen killed with five cartridges at distances of 110 to 160 yards five chamois whose size may be judged from the fact that when cleaned and weighed it was a very big one that would turn the scale at four stone. The red deer forms a much larger mark, and in one respect, perhaps, the interest of stalking is so far diminished that the shot, if it can be deliberately taken, may be considered a certainty up to 150 yards, so accurate is the rifle and so immaterial an error of a few yards in judging distance.

It will be convenient here to say something on the subject of breech actions for sporting rifles. The magazine is for nearly all purposes admirable. It is true that the opening and closing of the bolt in loading from it is apt to make a noisy clicking, and this is urged as a disadvantage. If, however, the breech be opened and closed, as the hand can be trained to do it, the instant after pulling the trigger, the noise of reloading is really lost in the echo of the shot; such, at least, is the experience not only of the writer, but of some of his friends. It is certain that the magazine action is amply safe; most forms of it have excellent safety bolts. It has the advantage of cheapness over the falling-block actions, which offer the only alternative for single-barrel sporting rifles, and still more over the break-down form of action universally applied to shot-guns and to double-barrelled sporting rifles. There was difficulty at first in producing double-barrelled rifles in the smaller bores on the latter principle because of the high pressures involved, which were apt to be too much for the action. This difficulty of manufacture has now been overcome, and good double-barrelled rifles are made in these calibres. There is great question, however, whether for such game as we have been speaking of there is any advantage in double barrels. Many deer-stalkers used to prefer the single Express to the double as being handier, safer, and less liable to damage from a blow. The advent of the magazine has made the single rifle almost as rapid as the double.

If we come to dealing with large and dangerous game the case is altered. At the critical moment of a charge from a wounded animal it is certainly better to have the two barrels ready loaded, and requiring only a second pull of the trigger to discharge the second shot, than to have four or five spare cartridges in the magazine which have to be loaded separately into the barrel, however rapidly this can be done. But where dangerous game is not in question, the double barrel hardly seems to give a material advantage.

There is another reason which has aided in depriving the double rifle of its popularity. Formerly the weight necessary to control the recoil of the Express rifle was considerable, and a single rifle was almost necessarily heavier on this account than it needed to be for considerations of strength of breech action and barrel alone. The double rifle was therefore but little heavier than the single. At the present time, with small calibre rifles of high velocity, the recoil is so small that the single rifle can be made much handier and lighter than the old Express, and consequently the double weapon involves proportionately more weight. It is never easy to adjust the barrels of a double rifle to shoot precisely together. The movement of recoil, which begins before the bullet has left the barrel, affects the direction in which the bullet is delivered, and the barrels have to be set so as very decidedly to converge towards a point some little way in front of the muzzle, more especially when heavy charges are fired. The adjustment of the barrels is very capable of being disturbed by a blow or strain.

With magazine or repeating weapons the rapidity of loading is such as to have enabled Dr. Carver, in his exhibition shooting with the Winchester rifle, which had a lever action, to fire two shots towards a glass ball thrown into the air, but purposely missing it, and with the third shot to break it before it could reach the ground. Single-barrelled shot-guns, with mechanism actuated by a moveable handle in the fore end, operated by the left hand, are sometimes used in America and by a very few sportsmen in this country. The power of firing five or six shots in rapid succession without even loosing hold with either hand of the gun, gives an advantage that may counterbalance some degree of unhandiness in the weapon itself. The probability of a largely increased use of rifles and shot-guns made on this principle is not great, but if anything of the kind is really required it may perhaps take the form of a good magazine 'scatter-gun' with automatic loading. It is perhaps as well in the interests of sport that, ever since the time of Dame Juliana Berners, at least, the wariness of wild animals has kept pace with the increase of destructiveness in weapons, and is likely to continue to do so.

A difficulty of the single-barrelled rifle with either the falling block action or the bolt action used to be that it was impossible to shorten the rifle for the purpose of packing it. Herein lay a decided advantage of rifles with the break-down action like that of the ordinary sporting gun, which enables the barrel to be detached from the stock. But it is quite possible to arrange for the barrel to unscrew from the action, if it be properly fitted and secured in place by a keeper screw. In military arms, and in others from which there is no need to detach the barrel, it is well to have it screwed so tightly home as to require considerable force to detach it; but where a rifle is to be used for sporting purposes, and handled carefully by those who understand how to clean and put it together, &c., there is no disadvantage, nor any appreciable loss of strength, in making the barrel detachable. Sporting rifles thus arranged have well stood the test of rough usage on more than one continent. It is possible by this arrangement to carry two barrels, both fitting the same stock, in case of accident.

A new type of sporting rifle has recently come to the front. The very high velocity which smokeless powder will give has enabled far greater effect to be obtained from rifles of the same calibre as the old Expresses than was possible with black powder. If the old rook-rifle calibres can now do all the work of the old Expresses, the Express calibres can now be made as effective for large and dangerous game as the old 8-bores and 4-bores. These rifles are not unduly heavy, nor is their recoil unpleasantly severe, yet they fire a comparatively weighty bullet. A new form of ·450 rifle, for instance, fires a nickel-covered bullet (fig. 55) of 480 grains, similar in weight, that is, to that of the Martini-Henry rifle, with a charge of cordite giving it a muzzle velocity of 2,050 f.s. The

FIG. 55

FIG. 56

FIG. 57

FIG. 58

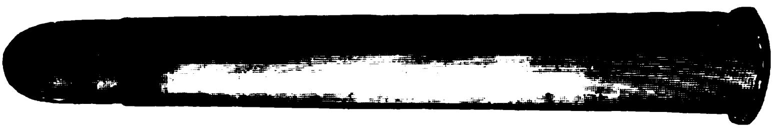


FIG. 59

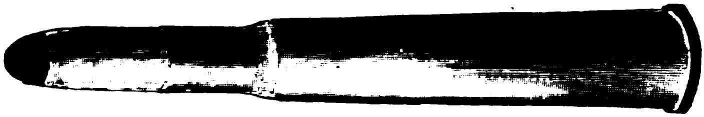


FIG. 60

striking energy in consequence is fully 4,500 foot-pounds, or just double that of the ·450 we have quoted in connection with the 'Field' rifle trials, which fired a bullet of only 322 grains, and had a velocity of 1,777 f.s. The energy, in fact, is considerably greater than it was with the ·577 Express firing a very heavy bullet weighing 591 grains. Similarly the striking power of a smaller rifle of ·350 calibre is nearly equal to that of the old ·500 bore. Fig. 57 shows the sheathed bullet for this rifle weighing 310 grains, and fig. 58 a bullet with a leaden tip. Fig. 56 is the similar bullet of the ·450 rifle. The complete cartridges are illustrated in figs. 59 and 60. Rifles of this class are handy, have short barrels, and do not kick unduly. The energy at the muzzle of the ·450 rifle is hardly equal to that of the 8-bore with a spherical bullet, but the bullet maintains its velocity better, and at quite a short distance it would be superior. Such rifles as these are fast coming into favour, and may now be had of all rifle-makers. Much care and ingenuity has been expended in their production.

Just as, with cordite, the same explosive composition is suitable for big guns or small rifles, the form into which it is put being varied, so, in these days, the same rifle and the same charge are suitable for game of very different kinds, if only the bullet be varied to suit the occasion. There is no other military rifle which has so great a penetrative power as the ·256 Mannlicher, but yet if this rifle be fired with a lead-pointed bullet there is no more deadly weapon for soft-skinned game of moderate size, such as deer, antelope, or mountain sheep. The ·303 is almost its equal, although the trajectory is not quite so flat. The initial energy is curiously similar in the ·303 and the ·256, as they each give a little over 1,900 foot-pounds. This energy, if it be rather less than that of the old Express rifles of larger bore than ·4, is better maintained, owing to the greater comparative length of the bullet. It may be said that the developement of smokeless powder and small calibres has added to the sportsman's battery an unequalled weapon for all-round work, handier to carry, quicker in loading, flatter in trajectory, and more accurate than any sporting arm before known.

It has always been found convenient in the wild countries of the world to have a weapon which, though mainly to be used for firing shot, would on occasion shoot ball. The muzzle-loading smooth-bores formerly used for jungle-shooting fulfilled this purpose, but when grooved barrels became necessary for big-game shooting, it was not found possible to obtain good shooting from them with small shot. The virtue of the rifle in imparting a rotary motion to its projectile has a most unfortunate effect when small shot is in question, since the centrifugal force imparted to the charge tends to cause it as soon as it has left the muzzle to scatter in the shape of a ring, and to put its shots, unless at quite close quarters, anywhere but on the mark aimed at.

Mr. Charles Lancaster many years ago solved the problem by producing a gun which had grooving enough to spin the bullet, and yet would make fair shooting with shot. The demand for such a weapon was not then much developed. In 1886 Messrs. Holland brought out the Paradox gun, the invention of Colonel Fosbery, who many years before that had invented and used an effective rifle shell, and who has recently succeeded in adapting an automatic loading and cocking arrangement to the revolver. The Paradox gun may be described as an ordinary gun with an exaggerated choke at the muzzle, the choked part being rifled with several grooves inclined at an angle. The conical bullet, when fired, travels up the smooth part of the barrel, and in the last three or four inches just before leaving the muzzle is caught and twisted, the sharp lands of the rifling cutting into it, and so leaves the muzzle with an ample spin to keep it steady. This gun, which makes very close shooting with shot, is a capital weapon for general work, but it would be hard to say that it is better than various other guns designed for the same purpose by different makers, whether they be called Ubique, Colindian, Cosmos, or by any other fancy name. The principle of these is, generally speaking, to give the smallest amount of rifling which will spin the bullet, an amount which appears hardly to influence the flight of the shot. It is in turning out such weapons as these, the success of which depends upon small measurements and accurate work, that the mechanical advantages of the present day are most noticeable. The sportsman of to-day can carry a weapon really accurate and effective with either ball or shot, an advantage unknown to former generations. Such weapons as these are better than the best of the arms with which in old days large and dangerous game had to be dealt with in all parts of the world.

It is curious to reflect that up to a little more than twenty years ago, the normal rifle used for shooting small game, such as rooks and rabbits, had a calibre of ·360 or ·380, decidedly larger than that now in use for military rifles. These weapons, almost invariably single-barrelled, and with some simple breech-action (for no great strain was involved by the small charge of powder used with them) were naturally not very costly articles to produce. Their predecessors of the muzzle-loading days had been of still larger bore, and fired spherical or belted bullets, or short conical ones. They were capable of very accurate shooting, but their velocity was not high, and consequently their trajectory was a good deal curved. They were displaced by rifles of ·360 or ·380 bore firing conical bullets, which, as made for instance by Messrs. Holland, were charming weapons to use. Such rifles were extremely accurate, and in this respect afforded a welcome contrast to the cheap and badly made rifles of the same type, which, like the poor, are always with us. If properly held they would not miss a sparrow up to 50 yards, while the bullet was large enough to have a crippling effect if it failed to strike an immediately vital part. This type of rifle was really much more powerful than was needed for the small game for which it was used. The writer has often shot fallow deer with it, and found it amply powerful enough for that purpose, if the bullet was placed, as in killing venison in a park it was possible to place it, exactly in the right spot.

A reduction of calibre has since that time taken place. In 1883 Messrs. Holland introduced a rook rifle, ·295 bore, with a smaller charge of powder (10 grains), and a bullet weighing 80 grains, which was extremely accurate, as is shown by the diagrams given by Mr. Walsh in his book. Other rook rifles of ·320 and ·300 bore were introduced at about this time. It is possible that the Morris tube, a rifled barrel of small calibre, arranged to be fitted inside the barrel of the military rifle for gallery practice, and which was of ·230 bore, had its share in drawing attention to the feasibility of reducing the calibre of small-bore rifles.

Perhaps the pleasantest, and certainly not the least accurate, rifle to use for small game is the American Ballard rifle, or some variety of it, such as the Colt, Marlin, Winchester, or Stevens rifle of ·220 to ·250 calibre, with a small rim-fire cartridge firing a bullet of only some 18 grains, or a longer central-fire cartridge containing a comparatively large charge of powder. The accuracy of a good rifle of this kind, such as will hold its own in the gallery shooting so popular in America at 25 yards, leaves nothing to be desired. The writer had one some years ago, which he fitted with an improvised telescopic sight, and with which he found that excellent practice on rabbits, &c., could be made. The bullet is so small that it requires to be put quite in the right place to be certain in its effect, and as with the ·220 rifle the velocity with a charge of 7 grains is only about 950 f.s., the trajectory is very much curved, and it is not well to take shots at any great distance. With this low velocity there is a distinct interval between the noise of the explosion and the thump of the bullet as it strikes. Where a careful shot can be taken, the head of a rabbit is a large enough mark to give almost a certainty of killing up to about 30 yards, and its body up to more than 50 yards. To stalk rabbits in the evening, or to wait in concealment near their burrows for them to come out and feed, is pleasant enough work, of a very lazy kind, in fine summer or autumn weather, and if the direction of the wind be observed, and, above all, if only such shots be taken as can be killed dead, a moderate bag may be made in no very long time, especially towards sunset. The very small amount of noise made by these little rifles is a point very strongly in their favour. The use in them of smokeless powder gives an even greater advantage in this respect, but, so far as the writer's experience goes, the accuracy with it is not equal to that of the black powder cartridge. With the latter it will usually be found that there is some falling off in accuracy after a score or two of shots, and in rook shooting, or on any occasion when a large number of shots are fired, it is wise to carry a cleaning-rod, and occasionally to wipe out the barrel. The charges used are so small that with the soft lead bullets which they fire there is scarcely any wear and tear of the barrel, and these rifles should last an unlimited time, if it were possible, as it hardly ever is, to keep at bay the great enemy, rust.

To this end unremitting attention is necessary, for, as with all other rifles, so especially with those of very small calibre, a small amount of rust or honeycomb will destroy the accuracy of the shooting. Owing to its size, the barrel is extremely difficult to clean.

This is the most useful type of rifle with which to teach the rudiments of the art of shooting, and is well adapted for practice in a garden, in a covered shed, or even indoors. It is used with great success by some ladies who make marksmanship one of their amusements, and cases has even been heard of in which such large game as roe deer has been killed with it. It is neither necessary nor desirable to use for shooting rooks and rabbits rifles of much larger calibre or of much higher velocity than this. There is certainly more likelihood of killing if the bullet does not strike quite where it should, but this fact encourages long shots, and when an animal is killed it is always considerably damaged.

A new use in this country, though an old one in America, has been found for rifles of small calibre carrying a light charge. The establishment of a large number of rifle clubs, many of the members of which depend for the bulk of their practice, if not for the whole of it, upon a range which is quite a short one and perhaps covered in, has created a demand for such weapons, and the ingenuity of rifle and ammunition makers has now for some little time been taxed to produce simple, accurate, and cheap weapons, and cheap ammunition with which good practice can be made. Perhaps the best known of such rifles is Greener's Sharpshooters' Club rifle, but there are few good rifle-makers who cannot produce a weapon suitable for club use. The small-bore American rifles already mentioned are also extremely well adapted for work of this class. Such rifles, whether English or American, have not velocity enough to make really good shooting beyond about 100 yards unless the weather be exceptionally calm, but there is a great deal of satisfaction to be got out of their use, and for the instruction of the young they are invaluable. The Bisley meeting of 1901 showed that the Greener rifle is capable, under good conditions, of putting nine shots out of ten into the 2-inch bull's-eye at 100 yards—

a very fine performance, which speaks well for the ammunition as well as for the rifle. The National Rifle Association, in giving prizes for this class of rifle, have particularly made it an object to encourage the production of arms and ammunition which shall be worth using, and can be used freely at no great expense. The large and increasing demand for such rifles and ammunition for the use of clubs cannot fail to make an improvement in them all round, both as regards quality and price.

The small rifles which are to be found at gallery ranges, at fairs, and at exhibitions are usually beneath contempt. Whether, under any circumstances, they could make good shooting no man may know, for they seem to live in a permanent condition of extreme foulness. The sighting is hardly ever correct. The probability is that the barrel has suffered from rust, while it is certain that the pull of the trigger is just as the wear and tear of many months may happen to have left it. Nothing can be more disappointing than to attempt to make accurate practice with such rifles as these.

There are several kinds of miniature ammunition which can be used with rifles ordinarily carrying a heavy charge. The best known of these is that for the Morris tube, which has passed through several phases since it was first made for the Snider rifle. In rifles of so large a calibre as that and the Martini-Henry it was absolutely necessary to use some such means of diminishing the bore for practice with a miniature cartridge. The cartridge is bottle-shaped, being of ·297 calibre near the base and ·230 at the neck. The Morris tube is also used with the ·303, and has hitherto been the only arrangement by which it has been lawful to fire a miniature cartridge with the Service rifle. Very good shooting can be made with it, and it is almost unnecessarily powerful, since, under good conditions, it will make very fairly accurate practice at 200 yards, while even at 500 yards a wound from its bullet might be serious. But, like so many other small bores, it suffers a good deal from fouling, unless the ammunition be exceptionally good, and after a few shots is apt to require cleaning out. Several other systems have been brought forward at one time or another by which a miniature leaden bullet may be fired through the actual barrel of the rifle, but so far as we know there is none at the present time which can be said to be entirely satisfactory. It seems clear, however, that it is worth while to save the expense of such a piece of mechanism as a separate tube fitting into the barrel, and also that the wear and tear of the barrel from its use with a small cartridge is inappreciable compared with the damage which it suffers from the ordinary ammunition for which it is made. Further, the rifle can be fired without any derangement of its ordinary balance, such as is inseparable from the use of a tube or any appliance which adds weight to the fore part of the barrel. We may confidently anticipate that the great attention now being devoted to the use of miniature cartridges in the Service rifle, both by rifle clubs and by the military authorities, will lead to further improvement in them.

One form of adaptor is in the shape of the ordinary cartridge case, with a striker running through the length of it as far as the neck. What is practically a pistol cartridge is fitted into the fore part of it, so that the bullet lies in the barrel. The ordinary mechanism of the lock when fired drives forward the striker in the dummy part of the cartridge, and this, impinging on the cap, discharges the shot. Another form of adaptor which seems very promising consists of a chamber-piece, which fills up the chamber, reducing its calibre to that of the barrel, and leaves only room for the small cartridge to lie in it. The bullet, when discharged, thus passes along a short length of smooth cylinder, and then jumps into the rifling. A third system, by which the Service rifle is altered for gallery targets, consists in boring it out to a larger calibre, so that a short cartridge of the same external size as the base of the ordinary cartridge can be fired from it. This entails the disadvantage that the weight and balance of the rifle are altered, and that it is impossible to fire the full charge from it. It hardly seems practicable to devise a miniature system which will enable firing to be done rapidly from the magazine.

A great difficulty with miniature cartridges is that the sighting is usually quite different from that of the full charge. With the old rifles it was necessary to have a false fore-sight in order to hit the point aimed at with the Morris tube, the difference arising from the smaller movement of the rifle under the influence of a small charge.

The targets made for the Morris tube are proportionate to the distance, and are such that according as the sight is raised, so the bullet when aimed at a particular point strikes a figure representing the target for the distance in question which is drawn at the proper height above the bull's-eye aimed at. By this means practice is secured in using the sights with the flap up as well as with it down on a gallery range, and a further advantage is gained, that the upright-ness of the sights becomes a far more important factor in obtaining good results than is the case in ordinary short-range practice.

CHAPTER VI

THE STANDING POSITION—PULLING THE TRIGGER—A SWISS MARKSMAN—THE DRAW PULL—THE HAIR TRIGGER—TRAINING THE MUSCLES—THE USE OF THE SLING—KNEELING POSITIONS—THE SITTING POSITION—THE PRONE POSITION—THE BACK POSITION AND ITS VARIETIES

There are quite a number of books, beginning with the official military works, in which different writers have laid down directions for acquiring the steadiest attitudes in which to fire without a rest, and it is a subject to which the beginner will find it worth while to devote serious attention. He will do well to discover from practical experience what are the elements of steadiness in holding the rifle, and so to acquire that promptness of manipulation and readiness of co-operation between hand and eye which lie at the bottom of all successful shooting. We seem to be entering upon something of a new epoch in these matters. In the old days of slow loading and firing, and of rifles giving no great velocity, it was not, as it seems now to be, absolutely impossible to cross open ground in the face of infantry holding a position. Concealment in war has now been raised to the level of a first necessity, and the practice of it is almost a fine art. It follows that the occasions for shooting in the lying-down position, and from behind entrenchments or natural cover that will allow of the rifle being rested, must become far commoner than hitherto. Such have always been the conditions of sport in stalking, or for a deliberate shot at long distance. But there will always remain many circumstances, especially when from any cause the shooting is at rather close quarters, under which it is not possible to use a rest; it may be because of intervening ground which requires the shooter to rise if he is to see over it, or because long grass, crops, or hedgerows have a similar effect.

To shoot with any confidence in the standing position even when firing at a mark of some size requires much practice, and the young shot cannot do better than determine to make himself proficient in it. He will improve his all-round shooting appreciably. It is better to begin with a rest than to begin by missing the target. A useful appliance, shown in fig. 61, for helping to support the beginner's rifle while he is taught the standing position, is used in some of the musketry schools abroad. It consists of a wooden upright on four feet, on the top of which is a crosspiece with half a dozen steps cut in it, each about an inch deep and wide enough for the rifle to rest comfortably on it, so that every man can find a support for his rifle at the proper height. The standing position admits of many variations. The position as generally used upon the Continent, and by the bulk of those on the other side of the Atlantic who go in for off-hand shooting, is very different from the military standing position as it is taught in this country. In either case, the body having been turned half round, the feet are firmly planted on the ground, having been well separated so as to obtain a wider base of support, and the knees are braced up and the whole body stiffened. The left hand, in the 'Hythe' or military position, grasps the rifle fairly well forward, and supports it especially upon the hollow at the base of the palm, just above the wrist. The fingers should clasp it firmly, but not so as to interfere with a clear view of the sights. When the rifle is brought to the shoulder the left elbow should be directly underneath it, and the fore-arm inclined somewhat forward. This position is fairly represented in Plate XXII.

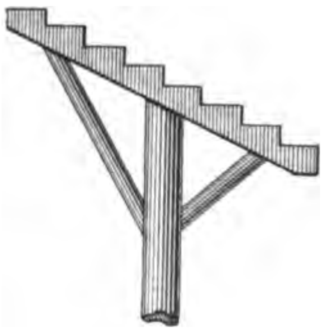


FIG. 61

In another variety of the position, and one which is excellent for quick shooting, especially if the rifle is light, or the muscles of chest and arm very strong, the left arm is extended almost straight under the rifle, after the modern manner of holding the shot gun. But the great heat of the barrel after a few rounds, especially in warm weather, makes it advisable generally to hold the rifle behind the back sight,

PLATE XXII

AMERICAN MARKSMAN SHOOTING STANDING, 1848

M

where the handguard protects the fingers. The fashion of raising the right elbow well away from the body is often exaggerated into keeping it almost higher than the shoulder, but this is unnecessary. It is well to keep the upper arm clear of the kick, and it is necessary to avoid carefully any tendency to cant the rifle to one side by lateral pressure upon the side of the toe of the butt, such as may be given by the upper arm near the shoulder, but the grasp and the pull on the trigger are rather interfered with if the elbow be too high. It used to be taught that the work of holding the rifle steady and well pressed against the right shoulder was the particular function of the left hand, and that the right hand had no share in this work, but had merely to apply the necessary pressure to the trigger. Yet nothing is lost by holding the rifle firmly with the right hand, and some additional steadiness is acquired. The trigger is usually pulled with the forefinger, but some prefer to use the middle finger for the purpose. It is doubtful if anything is gained by doing this with any ordinary rifle, though the depth of the action in the Martini-Henry made too wide a stretch between the thumb and forefinger to suit some hands.

Without holding, perhaps, the extreme view which Mr. Metford used jocularly to express by saying that it was evident that the forefinger had been created for the purpose of pulling a trigger, one may at least say that hitherto no more convenient means of discharging a firearm has been produced. An alternative idea has not unfrequently been hit upon, that the trigger should be arranged in the form of a catch or button on the upper side of the stock, so that it could be released by pressure with the thumb. This is represented as avoiding the tendency to pull off to the right, which, with a very stiff trigger and a very inexperienced marksman, is sometimes the result of pulling with the finger. But, in fact, the advantages of the thumb trigger are *nil*, and with any rifle in which the kick is appreciable, it is decidedly more likely to lead to injury or soreness of the digit than the ordinary trigger. It must be remembered that leverage and command of the pull-off are to a great extent lost if the pull is made with the end of the finger. The trigger should be pressed by that part of the finger which is just above the middle joint. Pulling with the tip of the finger is apt to give the rifle a wrench sideways as it is discharged, and any tendency to this must be avoided. The pull should always be directly backwards and upwards.

In what we may for convenience call the foreign position the upper part of the left arm is rested upon the chest, and the rifle is held by the left hand almost or quite as far back as the trigger guard. It is even possible for a bony individual to rest the left elbow upon the hip, and in this way to get something of a support for the rifle. Continental match rifles often have a special handle, consisting of a rounded disc of wood on a stem four or five inches long, projecting downwards from the fore-end in front of the trigger-guard, so as to rest conveniently on the palm of the left hand.

The use of this position is apt to lead, for target purposes, to irregular devices for obtaining additional steadiness, such as padding the chest out under the coat, supporting the rifle close to, or under, the trigger guard on the tips of the extended fingers, &c. These are difficult to prevent but quite undesirable, but they are freely resorted to, both on the Continent and elsewhere, when the conditions allow.

The following extract from a book entitled 'The Royal Rifle Match,' published forty years ago by Dr. Scoffern, describes vividly the standing position as exemplified by the Swiss marksmen who attended the early Wimbledon meetings:—

'The anxious moments of firing are now come round. See how the Switzer employs them. He begins by planting his legs wide apart; left leg foremost. He tries the ground under him for a moment or so, to find whether it be soft; and if he can wriggle out two little graves, one for each foot, the better. Should you have turned away your eye for a moment, and then direct your glance at the Switzer again, you will have found him half as big again as he was when you last saw him. He has puffed himself out with a deep breathing, like the frog who aspired to become a bull. By this deep inspiration, the Switzer has stiffened himself, just after the way one takes the limpness out of a Macintosh

Front Rank make ready.

Present.

POSITIONS FOR FIRING IN THREE RANKS, 1803 cushion—by filling it full of wind. The Switzer is firm planted and rigid now; he could no more bend from side to side than can a hard-rammed sausage. If he were obliged to hold his wind as long as we take to tell our tale, it would be bad for him. He would burst outright, like an overcharged rifle. Well! with legs apart—like a little Rhodian Colossus, and bated breath—the Switzer shoulders his piece. At the end of the stock is a boss, which he tucks between the right arm and right ribs. Gathering his two hands close together, he rests his rifle on the left hand, placed close in front of the trigger guard; pressing his left elbow, not on the left knee, indeed—but upon the left hip. Lot's wife could hardly be more rigid. Limited power of motion, nevertheless, the Switzer has. Heavenward you see his rifle pointing, and if you observe the Switzer's nose—that organ, only given for ornament, as some affirm—it is turned to a purpose of utility. The Switzer is steadying the butt end of his rifle against it. His nose is a lateral rest. By this time that nose is red on the tip, the face turgid, the eyes projecting. The Switzer's whole position is decidedly not graceful—one very suggestive of extrusion. Heavenward you see the rifle pointing. Gradually down and down it droops. The blank is seen, the trigger pressed. Rifle crack and Switzer's grunt follow on the heels of each other. He could not hold his breath for ever. Picket and imprisoned breath both fly off together. Behold him 'now panting and puffing like a Cinghalese pearl-diver, fresh from the worrying of a ground shark.' We may observe, *à propos* of this last sentence, that a very prolonged aim in the standing position is unwise, if only because of the unsteadiness arising from holding the breath for more than a few seconds. In this, as in other positions, if firing under circumstances in which there is no hurry, the shooter must not hesitate to bring his rifle down, take some full breaths, and after a short pause aim again if he finds his shot likely to suffer from his own exhaustion or temporary difficulty in obtaining a proper aim.

Continental and American rifles are often made with a 'crutch' projecting from the heel and from the toe of the butt. These fit round the upper arm close against the

PLATE XXIV

STANDING POSITION, 1808

shoulder, and thus additional steadiness is gained. In what we have called the foreign position, the rifle is supported much more nearly parallel to a line passing through both shoulders, than in the Hythe standing position, and the liability to bruises from the recoil with a heavy charge is much greater.

The rules of our own National Rifle Association provide that the whole of the left hand must be in front of the trigger guard at the time of firing. This is a very practical restriction, intended to limit the artificial character of the position. There can be no doubt that if any degree of rapidity is desired the simple English position is best, and that it lends itself far better than the other to shooting at a moving object.

The illustration already referred to (Plate XXII) of an American marksman, which is taken from Chapman's 'Modern American Rifleman,' shows an excellent position, and a very steady man firing in it with a telescopic sight. Nothing, on the other hand, could be less practical than the position described in 'The Perfection of Military Discipline after the Newest Method . . . or the Industrious Souldier's Golden Treasury of Knowledge in the Art of Making War' (1690), from which the following quotation may be given:

'*Present.*—In this case, fall back with your right Leg, so that the left Heel be against the middle of the right Foot, suffering the Butt end to rise to your Shoulder, setting it fast, your right elbow, even with the height of the Peice, being ever ready to pull the Trigger with the Fourth Finger of your right hand, bending the left Knee a little, and keeping the right very steady, levelling breast high.'

'*Fire.*—Here you must keep true motion in drawing the Trigger, doing it all together, so that the Fire of a Battalion may give but one Report, or appear to be no more than one Flash, the body steady, and the Musket close to the Shoulder till the next word of command.'

The fashion of bending one knee and drawing back the right foot dates possibly from the time when a rest was used with the musket, and it was necessary to lower the shoulders and head so as to bring the barrel to the right elevation. We find it in the very beautiful plates of the manual exercise for musket and caliver in J. de Gheyn's book (1608). Plate XXIII, which is taken from 'The British Soldier's Guide or Volunteer's Self-Instructor,' 1803, showing the positions for firing in three ranks, serves to indicate how unimportant a steady position was with the musket. The ranks are well closed up, the front-rank man kneeling on his right knee, and having the feet of the man next behind him on each side of his right leg. The man in the third rank locks up close, with his left foot forward and his right foot well behind him, and only touching the ground with the toes, the knee being bent. All ranks alike seem to ignore the rule that the left elbow should be underneath the weapon; they raise it and keep it well away to the left. At such close quarters it was very necessary that the piece should be held in front of the soldier's body while being cocked, and pointed straight up into the air until the word 'present' was given. A long barrel must have been a great preventive of accidents in firing in three ranks. It should be noticed that the front-rank man has his bayonet fixed. There is an element of leisurely dignity in the aspect of the figures which seems lacking in the rank and file of the present day; we can find no time to cultivate repose of manner in the ranks. The modern Volunteer does not, like him of 1803, have to live up to the privilege of being exempt from the tax on hair-powder. The following description of the standing position is quoted from the same book: 'The rifleman half faces to the right, the butt is placed in the hollow of the right shoulder, the right foot steps back about eighteen inches behind the left, the left knee is bent, the body brought well forward, the left hand without having quitted its hold, supports the rifle close before the lock, the right elbow raised even with the shoulder, the fore-finger on the trigger, the head bent, and cheek resting on that of the rifle, the left eye shut, the right taking aim through the sight.'

The Swiss shooter is described by Dr. Scoffern as bringing his rifle down gradually upon the bull's-eye, and firing when it reaches the right level. A more common method, and one, to our thinking, far better, is to bring the sights gradually up to the mark. It is a sound principle never to lose sight of the object to be hit, nor can quick shooting be made unless the rifle is pitched up, so that the aim is at once on, or a little

PLATE XXV

STANDING POSITION, 1800

below, the object. In firing in the standing position without a rest it is hardly possible to hold a proper aim upon the bull's-eye, or the desired spot, for more than an instant at a time. Most surprising fluctuations and movements of the muzzle of the rifle take place. It may almost be said that the longer the rifle is held in position before firing, the more unsteady does it become, as the strain upon the muscles and the nerves increases. If there is any wind at all the unsteadiness is especially marked, and a breeze is apt to make extremely fluky work of the shooting. A good device for obtaining greater steadiness, not allowed in target competitions, but at times convenient in the field, is to hold a stick in the left hand and to grasp it with the rifle, resting the other end of it inside the hip. For a snap shot or a running shot this method gives, of course, no help.

The chief difficulty in shooting standing is to acquire so delicate and yet so perfect a command of the trigger that the final pressure can be applied to it in the fraction of a second during which the aim is correct. It must be confessed that with the British Service rifle the pull of the trigger is by no means well adapted to respond to any delicacy of touch. There are apt to be irregularities in the catching of the full bent upon the nose of the sear, and the trigger has, for safety, to be adjusted so as to need a pressure of at least 6 lb. to release the sear; nor is there any preliminary movement to show when the pressure applied is almost sufficient. In this respect gunmakers are careful to regulate more delicately the pull of the trigger in sporting arms, which demand only from 3 lb. to 5 lb. pressure. In the military arms of most foreign nations the difficulty of having the trigger neither too heavy for manipulation nor too light for safety is avoided by an arrangement known as the draw-pull, a normal form of which is shown in the illustration of the Mannlicher rifle in section (Plate X). The top part of the trigger is extended backwards, and the front end of it is hinged to a lever pivoted in front, and carrying the projection in which the bent engages. As the trigger is drawn backwards the lever is drawn downwards, until eventually the bent is released. But this motion is not continuous. A rounded hump on the arm of the trigger, rather behind the point at which it is joined to the upright, bears against the body above and forms a fulcrum. When the trigger has been drawn back a certain distance the fulcrum is transferred to a second curved projection at the hinder end of the arm, which gives less leverage and more movement of the sear. By this means the trigger yields at first to the pressure of the finger, and can be pressed back for half an inch or more, and in doing so brings the catch nearly to the point at which it is freed. A pressure of about 3 lb. is thus absorbed by the draw-pull; at this point the trigger ceases to yield to the finger without a decided increase of effort, and the firer knows that an additional pressure of some 2 lb., which he can add instantaneously, will release the sear and discharge the rifle. There is much to be said for this arrangement of trigger, although to hands accustomed to the ordinary English trigger it is very baulking, more especially for a hurried shot, until its use has become habitual. The writer has known men fail entirely to get off a shot both at the running deer at Bisley and at his live counterpart in the Highlands when they were unaccustomed to the draw trigger. But the habit of using it is rapidly acquired, and we believe it to be the safest and most convenient form of pull-off for military purposes. An attempt was made a dozen years ago or more by Fraser, of Edinburgh, to introduce it in his Match rifles, but the idea did not commend itself, and, indeed, the back position is that in which extreme refinement in the pull of the trigger is least important.

One form of trigger was no doubt specially developed in order to meet the difficulties of the standing position. The hair trigger, or set trigger, as it is also called, is said to have been invented by Wolff Dauner, of Augsburg, about the year 1543. It is an arrangement whereby, when the lock has been cocked, a forward push is given to the ordinary trigger, or some similar movement made, by which the discharge of the rifle is left depending on a second trigger of steel wire projecting in the front part of the trigger-guard. The least touch of the finger is then sufficient to release the striker. This allows of extreme rapidity of discharge, and the rifle can be fired at the exact instant when the aim is right, on giving

PLATE XXVI

STANDING POSITION. PTE. W. C. LUFF, LONDON RIFLE BRIGADE, 1901

merely a backward flick of the trigger finger, without any perceptible pressure. The hair trigger was at one time allowed in Swiss military arms, but has now been recognised as unpractical for war, though it is still used in many Continental rifle competitions and is often found in sporting rifles abroad.

The secret of success in shooting standing is constant practice in the position. The muscles of the arms, which at first feel that the rifle is very heavy, soon become braced up and hardened, and the legs learn to stand steady—not so easy a thing as might be supposed. The standing position can be learned effectively indoors, without firing a shot, and all the necessary command of the trigger and quickness of the eye in taking up the aim, can be acquired by practising daily for a few minutes at a spot, or a very small target, placed on the wall in a good light.

It is worth while to have the arms in good training. Dumb-bells, not too heavy, are useful. The old 'pump-handle' form of exercise, that is, throwing the rifle forward, and then bringing it to the 'present' and lowering it again a large number of times in succession, was a useful recipe for accustoming the arms and the body to their work. There is a very striking difference between the apparent weight of a rifle or gun picked up and carried for a short time, after months of indoor work, during which familiarity with it has been lost, and the same weapon when it has been handled for some hours every day; in the latter case the weight is hardly noticed. It is scarcely necessary, however, to adopt the method of the early Volunteer, whom 'Punch' represented as carrying in the street a heavy iron walking-stick of considerable size to accustom his muscles to the weight of the rifle. In all shooting, and not least in shooting standing, confidence and nerve tell quite as much as muscular condition, and sometimes more. The great practical objection to the use of the standing position in prize shooting is that the variations in the strength and steadiness of the wind are usually such in an hour or two, and sometimes even in a few minutes, as to make very serious inequalities in the conditions for competitors not firing quite at the same moment. On the Continent this difficulty is almost entirely obviated by covering in the firing-point and partitioning it off on each side, so that the wind does not affect the shooter's body or the rifle. Yet it is surprising what good work can be done in reasonably fine weather in the open air. The team which went from the United Kingdom to shoot against the United States representatives at Creedmoor, in 1882, did not afford to their opponents the easy victory at 200 yards which might have been expected, considering that the standing or 'off-hand' position was at that time, as always, assiduously cultivated in the United States, but very much neglected in this country. The British team, by dint of a few weeks' practice, became every bit as expert as their opponents in this form of shooting, as the scores, which are given in another chapter, will show.

The rifleman represented by Colonel Beaufoy in 'Scloppetaria' (Plate XXIV) might be known to be using a rifle and not a musket by his well-studied position and care in taking aim. We can almost see that he feels himself to be out of range of the enemy's muskets, and that he can afford to be very deliberate in returning their fire. His position is stated in the letterpress to be that practised by Colonel Beaufoy, a prominent member of the Duke of Cumberland's Sharpshooters, himself, and the picture, which may possibly be a portrait of the author, is entitled 'Experto crede.' The chief feature of the position is that the left elbow is rested upon the hip, which is thrust forward to meet it. The rifleman would be disqualified under Bisley rules for not having the whole of the left hand in front of the trigger-guard. He supports the rifle on the thumb and forefinger only; the other three fingers steady the rifle by pulling at the sling, which is shortened for the purpose.

The sling, which is attached to military rifles, affords an easy method of carrying them, and is also in many parts of the world added to sporting rifles. It can be used to assist in steadying the aim in most positions. In standing or kneeling it is sometimes twisted round the left forearm, and sometimes round the upper arm. It is arranged to be of such a length that, when so twisted, it is drawn tight as

the arm is bent to hold the rifle in the proper place. Thus it braces together stiffly the rifle and the arm. Another mode of using it is to have it of such a length that it simply passes over the left elbow, but this method is suited chiefly to the standing position. There are other small variations in the precise arrangement of it, as may be seen in the different plates which we give, but the principle in all is the same. In using the sling in this fashion there is a natural tendency to arrange it in such a way as would not be practical for shooting under other conditions than those of absolute deliberation, and it is important that this tendency should not be carried too far. The Volunteers of a hundred years ago commonly used the sling to steady the aim, as Baker's picture (Plate XXV) shows; and Colonel Beaufoy mentions that he has seen some riflemen fire with the sling passed round the neck, and others with it so lengthened as to be put under the right foot—this, presumably, in the standing position! The National Rifle Association has a very natural and proper rule that the sling used with the Service rifle should be twisted round the wrist or arm only, and should only be such in form and dimensions as is officially authorised, the maximum length being 54¼ inches. One method of using it, as well as an excellent standing position, is shown in Plate XXVI, which represents Mr. W. C. Luff, London Rifle Brigade, in the act of firing. The sling has often been used since the days of Ezekiel Baker in the back position, but now that the match rifle is limited in bore, and its recoil cannot be heavy, there is not the same object as formerly in passing the sling round the foot or knee.

The kneeling position is the one which naturally presents itself next. At the present day the only variety of it which is ever seen at target practice is that developed at Hythe in the early days of the Volunteer movement of 1859-60. This is a very artificial position, inasmuch as it is one which the undrilled mortal would never dream of assuming. Yet it has many excellent points, and seems to have been invented to meet the demand for a fairly steady position in which the soldier should not take up more room than he occupies when standing in close order in a rank with other men, while yet he is low enough to give ample margin for the rear rank, still standing, to shoot over his head. It is probable that the rare use in the future of close order and double rank for firing will be found to have deprived this position of almost all utility. The kneeling position laid down in the official firing exercises is a very good one. Thick-soled boots are a *sine quâ non* if steadiness is to be attained. The right foot is drawn well back behind the left, which points to the front, and the shooter then kneels down on the right knee, not leaning forward at all, but bringing his weight well back, and sitting nearly upright upon the right heel. To do this comfortably requires much practice, as it is something of a strain on the muscles, and it may seem at first as if a sufficient flexibility of the knee joint and thigh could not possibly be acquired. There are some men who think it quite impossible to make heel and buttock meet, but even for them perseverance will overcome the difficulty. Some men even sit, not on the heel, but upon the foot, which they extend or place sideways on the ground. The weight of the body being thus provided for, the weight of the rifle is taken by supporting the left elbow on the left knee. There is a little hollow behind the elbow joint into which thin men will find that the knee cap conveniently fits; the forearm, which should be nearly upright, supports the rifle. Much of the steadiness depends upon the triangle formed by the two feet and the right knee being as large as possible, and to this end the left foot should be kept well forward, pointing in the direction of the mark, with the heel well beyond the line of the left knee. The right knee should be brought round till it is almost square to the line of fire. The head and the right hand and arm fall into the same positions as for shooting standing. This position is best learnt at home. It will be found that anything which makes a bunch behind the knee, such as a thick stocking and knickerbocker band, adds to the difficulty of sitting upon the heel. The standing position and the kneeling alike share the advantage that, although they lack steadiness, the sights are seen more truly and with less effort to the eye than in the lying down positions. A great command of the trigger is necessary in the

PLATE XXVIII

KNEELING POSITION, 1800

kneeling position, although it is far steadier than the standing one, and far less liable to serious disturbance from wind. The kneeling position is not of great use to the sportsman, but some degree of proficiency in it is well worth acquiring.

In this, as in all positions, it must be remembered that no absolute rule can be laid down as to the best attitude for the limbs and body. We must fall back on general principles, since there is much variation in the human race in all three dimensions—length, breadth, and thickness—and only experience will tell precisely how any man will best be suited in detail. But the general principles do not vary, and the sensible beginner will conform with as little variation as possible to the position which he sees generally adopted by the most successful shots.

Plate XXVII shows Armourer-Sergt. J. H. Scott, of the Roxburgh and Selkirk Volunteers, one of the Volunteer champions of Scotland both at the Bisley meeting and in the South African war. He uses the rifle without the assistance of a sling, and there is no reason to think that his scoring would be better, were he to use one, than it is at present. But a majority of Bisley men use the sling to steady the rifle when kneeling.

It is an old joke that the cavalryman is not expected to sit upon his spurred heel. It is useful on occasion—but not for target practice—to be able to fire kneeling with the body raised off the heel, and this should to some extent be a familiar position. Up to about 1860 the art of sitting on the heel seems not to have been discovered. The soldier of 1803 (Plate XXIII) does not attempt to rest his elbow on the knee, and keeps his weight forward on the left foot. Nor does Baker's marksman (Plate XXVIII), who also does not rest the elbow on the knee. Mr. Gould in his book illustrates a form of the kneeling position which he has found useful for a quick shot in hunting in the West. The left knee is fully bent and the left elbow rests upon it, and the whole weight of the body is thrown forward. The upper part of the right leg is stretched out as far as possible to the rear, with the knee and foot on the ground, and does little but act as a support against the recoil. This position brings the rifle to a rather lower level than the military kneeling position, though higher than sitting. It is too cramped to be comfortable for a deliberate shot. The kneeling position as shown by Baker is very similar to this, but the firer does not crouch so far forward. In firing sitting or kneeling, if the left elbow is not supported, little, if anything, is gained in steadiness over the Hythe form of the standing position. Another form of the kneeling position may be improvised by keeping both knees on the ground and firing without any support for the arm.

An advantage which the kneeling positions have over sitting is, that the shooter can rise from them and stand up instantaneously, without needing to put his hand on the ground, while the feet are taking the weight of the body. But kneeling is not well adapted for sloping ground, however convenient on the level.

The sitting position has been described in the Musketry Regulations apparently for the benefit of the cavalryman, for whom the ordinary kneeling position is unsuited. Probably the reason why it has never been incorporated into the drill of the troops is because it requires more elbow room than the kneeling position, and so is not well suited for close order. Perhaps, too, the long side-arm, hanging from the hip, with which the British soldier used to be encumbered, made something of a difficulty. In addition to these things, it is indisputable that if the ground be at all wet or dirty, a larger portion of the person and of the clothing suffers in the sitting position than in kneeling upon one knee, and this is a consideration which has not been without its influence in the barrack square. But the sitting position is one in which, early in the history of the National Rifle Association, much shooting was done, for the lying-down positions came into general use later than the others. As in the case of kneeling, the details of the position depend very largely upon the particular construction and proportions of the individual. The same principle applies to this as to other positions, that the body must be turned rather to the right of the direction in which it is desired to fire, so as to bring the left arm fairly underneath the rifle. Both elbows can be

SITTING POSITION. SIR EDMUND LODER, 1901

rested on the knees, the feet being crossed, if convenient, or preferably kept well apart, the left foot always towards the object, and the right foot well away to the right front, both being placed flat upon the ground. With practice very good shooting can be made in this fashion. The Martin Smith prize for sporting rifles at Wimbledon was for many years shot for in the sitting position, and the scoring in that competition by the most prominent shots of the time was almost equal to that made since any position has been allowed in it.

This is the position illustrated in Plate XXIX, which shows Sir Edmund Loder in the act of firing with a sporting rifle. Many will find the position best with crossed feet, the elbows resting upon the knees or on the thighs above them. To shoot sitting is easy enough on ground which affords a slightly raised seat: on level ground, unless there is enough suppleness of body to enable the shoulders to be brought well forward, there is a tendency to topple over backward even without the assistance of the recoil. The sitting position, which brings the rifle to a less height than the kneeling, is better adapted than it for shooting at a moving object. They are both, to most men, less convenient in this respect than the standing position, in which the swing of the body and arms is unhindered by dependence upon any support. In the illustration which we give later on (Plate XLVIII) of Mr. Ranken shooting at the Running Deer, it will be seen that he rests the left elbow on the left knee, but stretches out the right leg upon the ground. The right elbow is thus freed from any tendency to cramp the free motion of the rifle in aiming at the moving target.

A variety of the sitting position sometimes used for target-shooting is as follows:—Sit down almost square to the right of the direction of the target, bringing the feet nearly together and keeping them flat on the ground. Draw up the knees as high as they will go. Fold the arms, resting them on the knees: the right hand alone holds the rifle, which rests upon the upper part of the left arm close above the elbow. The recoil is taken on the upper part of the right arm below the shoulder. The fingers of the left hand are tucked tightly in under the right arm above the elbow. The head being bent forward and the face inclined to the left, the eye comes into the proper place for aligning the sights. This is not a useful position in the field. We have seen good shooting made by a skilled shot with the rifle held in an almost exactly similar way standing, but it appeared not to offer any special advantages over the more usual varieties of the standing position, and would probably be inferior to them in a strong wind.

In the writer's opinion the sitting position is worthy of far more cultivation than it receives. He believes that for practical purposes, such as stalking game of any kind, and for use on service, it is generally more convenient to the isolated individual than the kneeling position. There may be occasions when the slight advantage in height given by the latter is of some value, but if we come to consider shooting in broken ground, or on a downhill slope, it is not at all convenient. The sitting position gives command of a much larger vertical angle of fire, and it is easier to shoot at a moving object, or one suddenly appearing somewhat to one side, without losing the balance. It is also by far the most convenient for firing downhill, but it is not very well adapted for use on ground which slopes upwards from the firer. It is fair to add that it has this drawback, if it be materially a drawback, that the rifle has to be held for the moment in the left hand so as to leave the right hand free to be placed on the ground to give support in sitting down and in rising. This, like the dirtying of the trousers, is, of course, a disadvantage if the utility of a military position is to be judged mainly from a parade-ground standpoint. In the sitting position a considerable help to steadiness may be obtained if a walking-stick, such as is usually carried when stalking, is rested on the ground between the legs, and grasped with the rifle in the left hand.

The lying-down positions are of two kinds. For both of them a clear field of view is required almost down to the level of the ground, and thus they are not suited for use even in long grass. The first, and much the most useful, is the prone position. This position has been very largely used in

PLATE XXX

PRONE POSITION, 1800

the South African war, especially where troops have had to move under fire over open ground. It is a position, too, most useful in stalking, but for the purposes of military parade it has always suffered from the very grave disadvantage that it dirties the clothes. It is a very simple position. Turn half right, and taking the rifle in the left hand, place the right hand upon the ground, and lie down forward as you are now facing, getting the lower part of the body well down on to the ground. Place the elbows on the ground, closing them inwards, so that the left one is nearly under the rifle, which is held fairly well forward (how far must depend on the build of the man) with the left hand. The knees should be straight, and the feet may either be turned outwards, with the legs well spread apart, so as to lie almost flat, or the right foot may be crooked round the left ankle. The splayed-out variety of the position is perhaps slightly the steadier of the two, and it is certainly that most generally in use, but if at all exaggerated it can hardly be described as neat.

The prone position is naturally far steadier than either kneeling or sitting. Its one disadvantage seems to be the tendency, which affects some a good deal and others very little, for the clearness of vision and correctness of aim to be consciously or unconsciously affected by the rather cramped position of the head. It is important for comfort that in this position, and, indeed, in all others, the clothing should not be at all tight round the neck; the modern high starched collar is eminently unsuitable to shoot in. Even in firing prone the rifle is by no means so steady that the wind cannot easily shake it. A very complete command of the trigger is necessary if the shot is not occasionally to be dispatched when the aim is not upon the right spot. The movement of the body and limbs due to the pulsation of the heart and arteries makes itself felt even when the breath is held, as it always must be, at the moment of finally pulling the trigger.

The position of Ezekiel Baker's marksman (Plate XXX) can hardly be called a very good one. He lies with his body and legs directly in the line of the target, and his left forearm seems to have been expressly lengthened in the drawing to assist him in holding the rifle well forward. The sling is gathered under the hand, and this of itself is something of a disadvantage in holding the rifle, though it matters the less as he has a rest to support his rifle.

The interesting photograph of that famous sportsman, Captain Horatio Ross, which we are able to give (Plate XXXI), was probably taken about the year 1867, when he was still shooting, though growing an old man. It represents him firing with the match rifle in the prone position, for the back position was not yet in vogue. Though his skill was admirable, his attitude is not specially pleasing to modern eyes. The right knee is bent, and the left foot raised upon the toes. The whole body lies more in the direction of the target than is thought well in these days. Yet there could be nothing very far wrong in the position, since he could win important prizes in it when approaching seventy years of age, notably in 1867 the Cambridge Cup, shot for at the extreme ranges of 900, 1,000, and 1,100 yards.

Plate XXXII represents Sergeant-Instructor Wallingford, of the School of Musketry, Hythe, who may fairly be said to be the most skilled marksman in the British Army at the present time. He fires with the sling stretched tightly round the upper arm.

On the Continent, where the lying-down positions are in less favour than they are in this country, the shooting is usually done, not from level ground, but from a platform sloped upwards at a considerable angle. The marksman lies with the length of his body absolutely in the direction of the target, a position which deprives the rifle of a large measure of support, since the left forearm cannot be brought fairly under it. The accepted explanation of this practice is that to lie diagonally to the line of fire is to present a much larger mark to the enemy. This might, perhaps, be the case in quite exposed ground, but the difference can hardly amount to a material drawback.

It will be found in this, as in the other positions, that a certain amount of practice will wonderfully improve the steadiness and trigger control. The right shoulder should

PRONE POSITION. CAPT. HORATIO ROSS, 1867

be brought well forward and the recoil taken in the hollow of it and not upon the arm. Special care must be taken not to tilt the sights to one side, which is far more easily done unobserved in this position than when standing or kneeling. There are many who maintain that the best results with the Service rifle are obtained when it is grasped very tightly. The writer believes that uniformity of the pressure of the shoulder and of the grip of the hands, important in all positions, is especially so in this if the best results are to be obtained. The learner should drill himself to see that his attitude and mode of holding vary as little as possible.

The second of the lying-down positions is the only one used at the present time in match rifle shooting, since it is unapproached in steadiness when a rest cannot be used with the rifle. This is the back position. It seems to have been very gradually developed. We find traces of it in the eighteenth century, as has already been mentioned in alluding to the skill of Colonel Ferguson, who could shoot 'lying upon the back or belly.'

The use of the back position in war may be further illustrated by the following quotation from the 'History of the Rifle Brigade,' by Sir William Cope. In describing an incident at Cacabelos during the Peninsular War (1809), he says:—

'It was now nearly dark; and General Colbert, who commanded the enemy's cavalry, conceiving probably that the Riflemen had retired, and that the English cavalry and guns were unprotected, made a most rapid and furious charge upon them with a mass of cavalry. The Riflemen again instantly threw themselves into the vineyards, and from the banks lining the road poured so hot and well-aimed a fire that the attacking cavalry were instantly checked. It was at this moment that Thomas Plunket, a private of the Battalion, noted for his excellent shooting, crept out with some expression that he "would bring that fellow down," and, throwing himself on his back on the snow-covered ground, he caught the sling of his rifle over his foot, fired with deliberate aim, and shot General Colbert dead. His orderly trumpeter rode up to assist him, but Tom Plunket had reloaded, and he also fell before his unerring rifle. He had just time to jump up, and, amidst the cheers of his comrades, by running in upon one of the rear sections, to escape the sabres of a dozen troopers who spurred after him in pursuit.'

The back position is depicted by Ezekiel Baker early in the nineteenth century (Plate XXXIII). The rifleman lies nearly flat upon his back, with the legs extended. He crosses his left foot over his right, and rests the muzzle of his rifle between the toes of his boots. The recoil is taken by the left foot, round which the sling of the rifle is passed. The butt does not appear to receive from the body any support against the recoil, and the head is unsupported. The left hand holds the rifle behind the small, and it is discharged in the usual way by the right hand. Colonel Beaufoy's description of the position is as follows :—'To fire lying on the back, the sling must be sufficiently loosened to let it be passed on to the ball of the right foot, and as the leg is kept stiff, so, on the contrary, the butt is pulled towards the breast, the head is raised up, till the front sight is brought into the after notch in the usual way; but as the position is not only awkward but painful, this method is very seldom used as a position of practice; to which must be added, that as many fire with holes instead of notches, it is not possible, from the distance of the hole of the sight from the eye, to take any direct aim, and therefore in this mode none but open sights can be applied.' The back position was revived, not long after 1860, by two or three ingenious marksmen, among others, Mr. Henry Whitehead; with one great difference, that the butt of the rifle was rested in the armpit, to take the recoil. Its real vogue in this country dates from a later time, that of its reintroduction from America by the American marksmen who had so much success against the British and Irish teams in the international matches of the seventies. It was found that where correct holding was a necessity no position was so steady. The aperture back sight of the match rifle had up to this time been most conveniently placed for prone shooting upon the small of the stock just in front of the right hand. Placed thus, it was too far forward to be very convenient for use on the back, if the recoil were taken in the

PRONE POSITION. SERGT.-INSTR. WALLINGFORD, HYTHE STAFF, 1901

armpit or by the sling passed round the foot, as has been already shown in the quotation from 'Scloppetaria,' although moderately good work could be done with it if a very large aperture were used. In spite of the rather heavy recoil of the old rifles, one position at least was developed which, to those prepared to face some discomfort for the sake of obtaining the best results, allowed the sight to be used on the small. This position is that known from its first inventor as the Fulton position (fig. 62) ; its most successful exponent in more recent days was the late Major Young. We copy an illustration of it from his excellent little book, 'The Three Rifles.' It required, perhaps, rather more elasticity of person and decidedly more moral courage than the other forms of the back position. The left arm was doubled back behind the

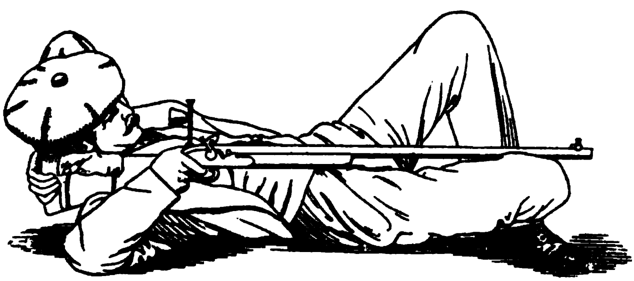
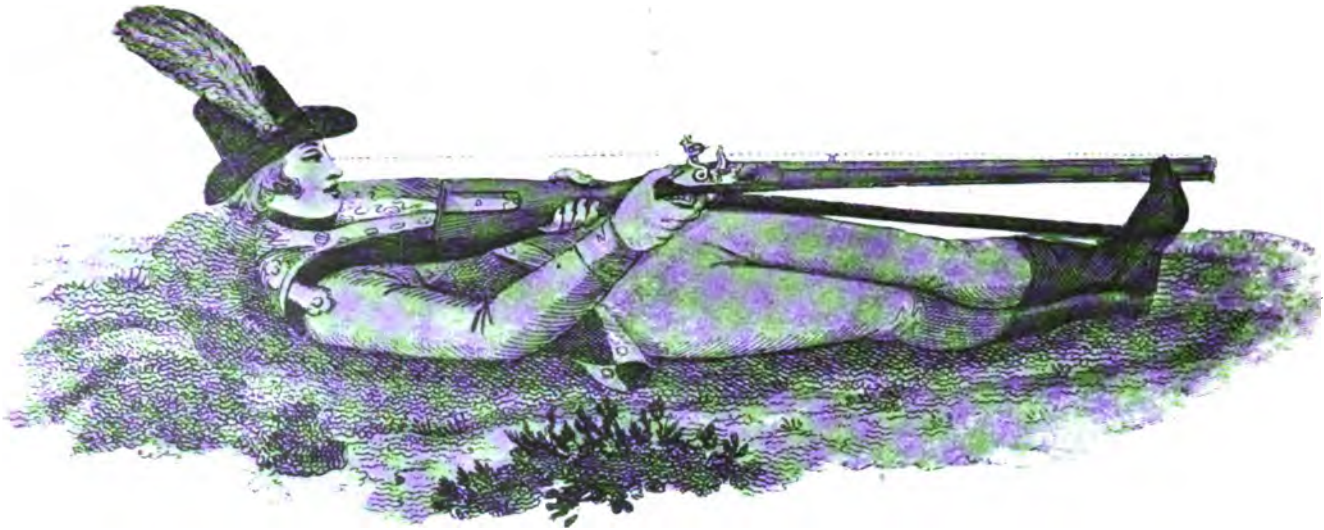


FIG. 62

head so that the forearm supported it, and the hand grasped the heel-plate of the rifle, which was passed behind the shoulder for that purpose. A small cushion fastened to the stock supported the cheek to save it from being bruised by the recoil, which, even so, was decidedly trying. This brought the eye into a position in which it was not far from the back sight, and the trigger could be pulled in the ordinary way by the right hand. But the hand was somewhat cramped, and very liable to have the middle finger damaged. The evident remedy for the difficulty involved by the distance in the ordinary position of the back sight from the eye was to fit it close to the heel of the stock, so that the eye could be brought close up to it, while the recoil was taken in the armpit. This arrangement, though it adds an element of difficulty due to variation of the sighting by the warping of the stock, has for many years been universally in favour among those who use the match rifle. The eye is protected from the slight blow of the recoil by an indiarubber cap placed upon the back sight. The position now adopted does not admit of much variation. Ordinarily the left foot is placed on the ground, with the lower part of the left leg almost upright; the right knee is crooked round it, so as to grasp it tightly just above the ankle, and the rifle is rested upon the inside of the right knee, close to the left leg, but preferably not touching it. Sir Henry Halford, as Plate XXXIV shows, shot in this position; it is the one in most common use to-day, and the writer's experience of it is very satisfactory. It is a better position than is obtained when the right knee is somewhat raised, and the rifle rested in the hollow between the two legs, since the rest obtained is decidedly a more solid one. Another and very neat variety of the position is to lie rather on the side with both legs straight out and the left foot crossed over the right, so that while the feet are close together a solid support is obtained for the rifle, which lies just behind the left knee. The left hand holds the stock just in front of the backsight. If, at the same time, the trigger guard can be conveniently rested against the body a little inside the right hip, additional steadiness is obtained. The left heel rests upon the ground. It might be added that this position is not compatible with a large 'corporation,' were it not for the extreme rarity of this phenomenon among successful riflemen. This position has been used for many years with great success by Mr. Henry Whitehead, whom our illustration represents (Plate XXXV).

One great aid to obtaining steadiness is to keep the left foot flat on the ground, and not, as beginners tend to place it, with the heel only on the ground, and the toes stuck up. In some forms of the position the head is well supported, and it may be taken as a rule that it is worth while to ease the muscles of the neck of any strain, although some successful marksmen are so strong in the neck as not to find this necessary. One means of obtaining support for

PLATE XXXIII

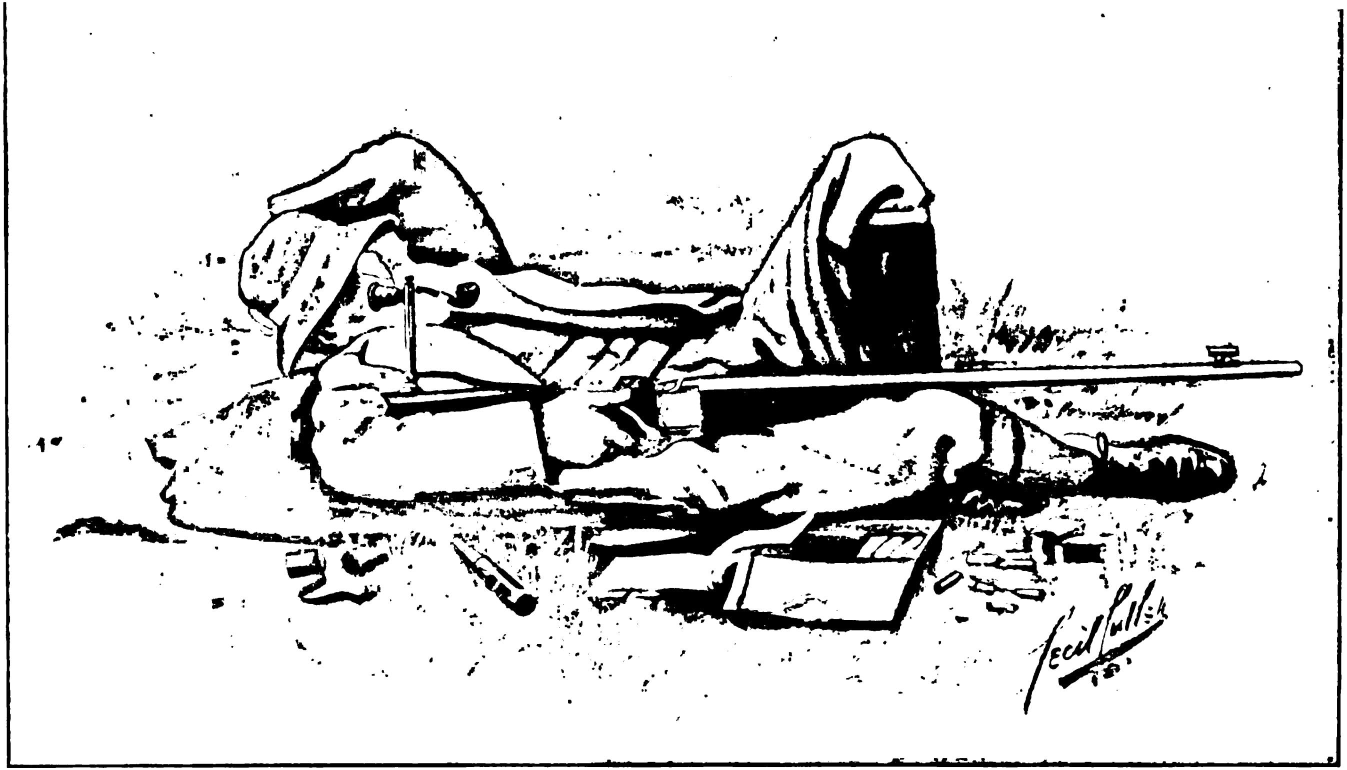


BACK POSITION, 1800

the head is by grasping the stock of the rifle with the left hand just in front of the back sight, holding with the teeth either a mouthful of the coat-sleeve or the end of a short strap passed round the left wrist. Sometimes a handkerchief is used for the same purpose; and there was once a rifleman who used to produce from under his waistcoat and hold in his teeth a mysterious-looking leather string, attached somewhere, one could not tell where, beneath his garments, in the region of the navel. Many men find a degree of discomfort in thus putting weight on the teeth, and the coat-sleeve or handkerchief is apt to become moist and unpleasant as well as damaged. Sometimes the right hand alone is used to direct and hold, as well as to discharge, the rifle; and in that case the left hand is free to support the head, either by simply placing the fingers round the back of the neck after the manner practised by Sir H. Halford, or by resting the tips of the fingers on the ground, the arm being doubled right back so as to form a rest for the head. The latter form of head rest the writer can recommend from personal experience. Brilliant shooting has been made alike by those who use both hands to hold the rifle, and by those who only use one, and it cannot fairly be said that to the well-practised shot the one system offers more advantage than the other. In one variety of the back position, now nearly extinct, and used by only two or three of those who frequent Bisley, the recoil of the rifle is taken, and the head supported, in the fashion already described, but instead of the knees being employed to form a rest for the rifle, they are both raised in the air, and inclined to the left; while the heels of both feet are on the ground, having the toes close together and projecting upwards. The barrel of the rifle is rested between the toes of the boots, which afford a sufficiently steady support. This attitude is unfortunately not at all elegant, and although it has been used by some very successful shots, it cannot be said to rank higher from any practical point of view than the more ordinary forms of the back position. Our illustration of that distinguished shot, Major J. K. Millner (Plate XXXVI), shows him in this position, in which for many years past he has made brilliant shooting at long ranges. He leans the head well over to the right, and aims always with the left eye, as may be done in most forms of the back position.

To the unaccustomed who attempts to arrange himself in one of the ways here described the position will seem extremely strange and awkward, but a very little practice will show the great advantages it confers. No position is really steady in a high wind, but the back position is far less unsteady than any other. The involuntary movements of the body and of the pulses alone make it impossible for any position to confer absolute rigidity. Mr. Metford used to say that in firing with a telescopic sight of considerable power, at 1,000 yards, in the back position, he found that owing to the pulsations of the body he could discharge only two shots out of three with the cross hairs actually within the 6-inch white circle which marked the centre of the bull's-eye on Sir Henry Halford's range at Wistow. This probably represents rather a high level of steadiness. It means that in the best shooting the error of aim is within the limit of about 1′ of angle, both vertical and horizontal, but that without some form of artificial rest the rifle cannot be held more steadily than this. The one great difficulty offered by the back position to those who are not both familiar with it and in constant practice is the difficulty of keeping the sights upright. As both body and head have to lean to one side there is an inevitable tendency to cant the sights over, usually to the left, that is, towards the body of the firer. This almost always affects the aim with ordinary sights, unless it is possible to level them along the lines of targets, or to align the upright part of the back sight with a flagpole or some such vertical line. If the head is not upright, but leaning to one side, the body, and the eyes with it, seem to lose all true sense of what is perpendicular.

The beginner who aims through the sights of a Match rifle fitted, as Match rifles are, with a spirit-level under the fore sight, will find it extremely difficult to attain the position in which, while he aligns the sights upon the mark, the bubble of the level is central. He will be troubled with a constant tendency in it to run off to one side or the other while he is completing his aim. Habit soon overcomes this



BACK POSITION. SIR HENRY HALFORD, 1893

difficulty, and an accurate aim can be held almost as long as may be desired. The military breechloader of a dozen years ago was fitted, like the Match rifle, with a spirit-level, placed, in this case, behind the back sight, where it was most useful and not liable to breakage. When once convenience and comfort in the back position have been attained it is found that a long series of shots can be fired without any appreciable inaccuracy of aim. In the highest class of team shooting it is absolutely assumed by the coach that every shot fired by those whom he is superintending has been perfectly correct in aim, unless he is told at the moment, as very rarely happens, that the shooter is not perfectly satisfied with the steadiness of any particular shot.

Very good shooting may be made in the back position with the military rifle, and without a spirit-level, but the aim requires great care; and, perhaps partly owing to the distance of the back sight from the eye, there seems to be rather more liability to optical errors than with the prone position. Where it has been sufficiently practised the steadiness of the position is entirely in its favour, and it is well worthy of cultivation for general purposes. It is extremely difficult to fire in the prone position at any long range owing to the very high elevation of the sights and the consequent craning of the neck to see over them—a great element of unsteadiness. With the back position, or some hybrid between it and the sitting position, this particular matter creates no difficulty at all. The back position, however, can never become effective for military use while the British soldier carries on his back quite so much gear as at present. In full marching order he can sit down, but he cannot possibly lie supine. Of one incubus he is, we may hope, shortly to be relieved. The helmet, in which he cannot shoot in the prone position, because it at once tilts itself over his eyes, owing to its long projecting peak behind, seems (in its present form at least) to be going out of fashion, and if it vanishes from the costume of our infantry will cause no regret to its wearers. Times and manners change, and the pendulum of fashion or of habit swings first one way and then another in the matter of positions as in all else. When the writer was first taught the use of the rifle at Eton practically all target-shooting was done in the back position, and this fact certainly made the use of the long Snider rifle possible for boys. Since then the kneeling position has been much in vogue, and the standing position, the finest test of nerve as well as of training, has been partly revived. The signs of the times now point to a much larger use of the lying-down positions, but it seems clear that the prone position will still be by far the most favoured.

BACK POSITION. MR. HENRY WHITEHEAD, 1901

CHAPTER VII

SIGHTING—MILITARY SIGHTS—LATERAL ADJUSTMENT FOR WIND—THE NOTCH AND THE BAR—FORE SIGHTS—THE BEAD SIGHT—PROTECTION BY A HOOD—SPORTING BACK SIGHTS AND FORE SIGHTS—THE LEWES SIGHT—ORTHOPTIC SIGHTS—MATCH RIFLE SIGHTS—WARPING AND LOOSENING OF THE STOCK

In the means employed to direct the barrel so that the bullet will strike the mark, that is, in the sighting, there is room for endless variation of detail. The principle, of course, is clear enough: it is to provide two points, one near each end of the barrel, which, when the rifle is raised to the shoulder, come conveniently into coincidence for the eye, and can be directed upon the object. These points must be such as experiment has proved to represent the direct vertical line in which the bullet is projected. Some form of adjustment, however, is necessary if the sights are to be used at more than one distance, as compensation has to be given in the aim for the fall of the bullet. Thus in the military rifle it is necessary to give such adjustment of the back sight as will enable aim to be taken at the mark, and a sufficient angle of elevation given to the barrel to compensate for the drop of the bullet in a flight of any distance up to 2,500 yards more or less.

In sporting rifles it is not necessary to have elaborate adjustment. With a good Express rifle, as used for deer stalking, sufficient accuracy can be obtained by having the sight set so as to shoot one or two inches high at 100 yards; aim can then be taken a little low at shorter distances than this, and rather higher for longer distances up to about 150 yards. Still, this method of making allowance demands great coolness, and it seems to be an excellent general principle that the adjustment for elevation should, whenever possible, be made upon the back sight, and the eye accustomed to take always a similar aim at the mark. Habit has, of course, a great deal to say to the precise form of the sight with which good work can be done.

In the days of the musket it was very correctly thought that any attempt to give accurate sighting was a mere waste of labour. The tapering form of the barrel naturally suggested what is the commonest and most rudimentary form of sighting, that of having some small knob or projection near the muzzle which is brought upon the mark, being directed by the eye looking either down the general line of the barrel, as in the shot gun, or over a little flat bar, fixed near the breech end of the barrel, and usually having a notch filed in the centre of it. This will give for a single distance the two necessary factors of correct direction and elevation.

The English pattern of military back sight is shown in Plate XXXVII, fig. 2. It has a hinged leaf, which lies flat upon the bed fixed to the barrel, but can be raised when it is desired to give elevation beyond a certain distance. It is in the form of two uprights, having a space between them, but joined at the bottom and at the top; on these uprights slides a cross-bar with a notch cut in the centre of it, and fitting them tightly enough to remain in place when adjusted to any of the elevations which are marked in hundreds of yards upon the uprights. When the flap is down a notch upon the fore part of it forms the sight for nearer distances; a certain degree of elevation can be given, without placing the flap upright, by moving the slide forward, when it rises upon an inclined plane and elevates the fore part of the flap sufficiently to give the sighting for the first 400 or 500 yards. All rifles are not correctly sighted for 500 yards with the flap down, and a specially narrow bar called the 'match slide' (fig. 63) is allowed to be used for target competitions, which gives elevation for 500 yards with the flap up.

FIG. 63

The form of back sight most favoured on the Continent, and one for which there is a great deal to be said, is hinged at the end furthest from the eye, and has a spring catch which can be adjusted into any one of a series of notches which give elevation for the different distances. Such an

BACK POSITION. MAJOR J. K. MILLNER, 1901

arrangement has one disadvantage, that very small changes of elevation, such as are made use of in target shooting, cannot be given; on the other hand, it is undoubtedly simpler for the soldier to use. The slide as we use it is very apt to be either too tight to be easily adjusted by the finger and thumb, or to become so loose as to shift with the jar of firing. On the whole, it would seem as if some modification of the Continental pattern of back sight may prove to be the most suitable thing for the soldier. In one variety, that recently adopted in Germany, elevation is given by moving a sliding piece upon a curved bed so shaped that, although actually the alteration in elevation for each 100 metres increases rapidly as the range lengthens, yet the spaces through which the slide has to be moved from one 100 metres to another on the back sight remain very closely equal. The principle of this sight is certainly excellent.

It is not only adjustment for elevation that is needed to obtain the best results. There are times when aim has to be taken at a considerable distance to one side or the other of the mark, in order to allow for the effect of the wind upon the bullet; it would, perhaps, be more correct to put the fact in this way, that there are occasionally times when a correct aim can be taken at the bull's-eye, and that these times are very rare.

At distances such as are in use with sporting rifles, there is no great necessity to have lateral adjustment, but for longer ranges and fine shooting, especially when the rifle is in skilled hands, it is undoubtedly desirable. Still, no European nation hitherto has really adopted the sliding wind-gauge as a feature of its military arm. There is certainly some difficulty in arranging the application of a transverse slide so that it shall not be so small and so stiff as to be difficult of adjustment by the fingers when they are cold or hurried, and yet that it shall not make a clumsy projection such as will court damage. If, however, we are to accept it as a principle that the weapon put into the soldier's hands is to be one capable of giving the best possible results when handled by those really skilled in its use, even if these are only a small proportion of the whole, it is clear that a back sight with lateral adjustment must be accepted as giving a very definite advantage at the longer distances.

In shooting at a mark, especially at a clearly defined bull's-eye such as the ordinary target affords at a short distance, the effect of the weather will rarely be such as to make it necessary to aim altogether away from it, but the allowance which has to be made at the longer ranges is at times very considerable. The writer has in his mind a time some years ago when strong westerly winds prevailed during the Bisley meeting, and for a week together the allowance which had to be made at 900 yards was more than 20 feet. Even with the large targets used at this range, the distance from the centre of the bull's-eye to the edge of the target is but 6 feet, and to aim in such circumstances 14 feet or more away from the edge of the target can only make very fluky work. There is nothing to guide the eye as to the exact amount of allowance to be given, because the target passes almost out of the field of view given by the notch in the back sight, or, at all events, even if it be still partly in view, it is not near enough to the point of aim to be any guide as to the precise direction for the shot. Further, one of the most difficult matters in making good shooting is to take an exactly similar aim each time in respect of elevation, and not to see more of the fore sight above the back sight at one time than at another. This becomes extremely difficult when the sights are aligned at some distance to one side of the mark. It is very easy to shoot too high or too low in aiming at a grass bank, or, perhaps, at a general view of the country; yet the elevation must be maintained if the shot is to be effective. These difficulties are obviated if it is possible to make an adjustment of the back sight to one side, and still to aim through the notch, or over the mark in the centre of it, directly at the object to be struck. On the occasion just referred to at Bisley, where the intervals between the targets are not very great, it is reported that some very good scores were made by careful men who found that they could give the right allowance by aiming at the bull's-eye of the next target.

Various methods of lateral adjustment of the back sight have long been used experimentally. The Americans, in the matches which they fired with military breech-loading rifles against British teams in 1882 and 1883, used a sliding wind-gauge upon the back sight similar to that allowed by the regulations of the National Rifle Association. They pressed hard, but in vain, for leave to use a wind-gauge with a screw adjustment, an arrangement which has never been accepted as practical in this country. For many years in the military breech-loading class at Wimbledon, in which the Metford rifle held its own so extraordinarily, the sliding wind-gauge was used with admirable results.

One disadvantage of the notch in the back sight, through which the fore sight is seen, is that it obscures something of the surroundings of the mark. This may be largely avoided by aiming over the straight bar, the centre of which is marked by a conspicuous vertical line, such as can be made by inlaying a little strip of platinum. If this be done, a certain degree of allowance can be made by aiming over the bar, with the fore sight not directly over the line, but a little to the right or to the left. This is the most favoured method of sighting with the military rifle in target competitions, and is used even at 200 yards, the sight being set at an angle so that aim can be taken over the bar, and readjusted for each shot—a very artificial method. The rules of the National Rifle Association allow black or white lines to be painted temporarily upon the bar. The average allowance necessary can thus be made by painting a white line as far from the centre as is necessary before beginning to fire. The minor adjustments are then made by aiming a little to the right or left of this line as the wind varies from shot to shot This is the most effective method, but it is not at all suited to the conditions of work in the field. At the same time it must be remembered that in target competitions it is necessary so far as possible to place all competitors upon an equality in regard to the conditions under which they shoot, and that many rifles have peculiarities in the way of sighting which would create unfairness. If it were not permitted to aim to one side or the other in this way, inequalities would arise. In some cases a man whose rifle was sighted correctly would have no advantage over those whose rifles shot to the right or the left. If the wind were from the right, the man whose rifle shot normally to the right of the point he desired to hit would have some degree of advantage, perhaps a great deal, and the reverse would be the case with the man whose rifle had a bias to the left. It would even be possible for a man who could afford to keep several rifles to improve his chances by taking out on a day when the wind was strong from the right, a rifle which shot wide away from the mark in that direction, and with a left wind to use a rifle of the opposite tendency, and thus the average man, finding himself at a great disadvantage, might throw up the sponge in disgust. It will be seen, then, that there is considerable excuse for allowing some form of adjustment. If a sliding bar were to be adopted for the military rifle, those incapable of using it to full advantage would shoot no worse than they do now, while the skilled shot would undoubtedly benefit.

The form of the fore sight of the British military rifle (Plate XXXVII, fig. 1) is one which seems to have been designed for strength rather than with special reference to its utility as a means of taking aim. The principal thing necessary in a fore sight which has to be used with or without a notch in the back sight is that it should be shaped so as to allow the eye to see promptly and definitely how much of the fore sight it is taking into view. If the tip of the fore sight seen over the back sight is conical (fig. 64), as it has hitherto been in British military arms, then the shape of the portion seen will be exactly similar, whether only the tip is taken or considerably more. The fore sights of foreign mili-

FIG. 64

tary rifles are as a rule not cone-shaped, but have parallel sides no great distance apart, with a broader top than ours, and consequently the amount of fore sight taken in aiming can be regulated by its apparent shape. If so much of it is habitually taken that the part seen above the bar is equal in height to the width of the fore sight, it will at once be noticed from the alteration of the shape in the part seen whether more or less than the normal is brought into view.

PLATE XXXVII

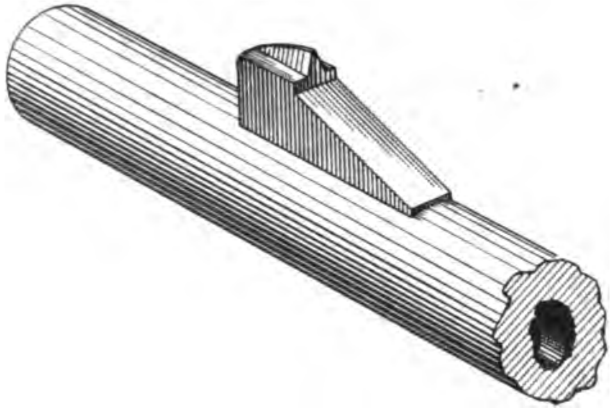


FIG. 1

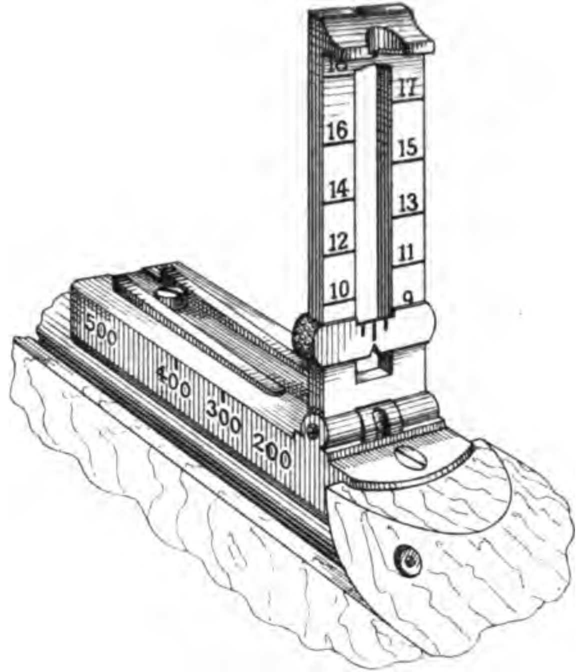


FIG. 2

On the same principle the bead sight (fig. 65) is used in sporting rifles, its virtue not being in its thin stalk, but in its being so shaped that it is at once noticeable if either more or less than the whole bead is seen above the back sight. Elevation, therefore, can be maintained with great exactitude.

There is much to be said for having some arrangement of the fore sight of the military rifle which will make the tip of it definitely visible as a thing the shape of which will at once make any error in the aim obvious. The best definition of the fore sight is obtained when the eye has to be guided not only by shape but by colour. A white tip to a black fore sight, or a white bead on a black stem, is picked up most quickly by the eye in aiming under ordinary conditions in the field; this is why of late years a bead of white porcelain has come very much into favour as a fore sight for sporting rifles. On the other hand, for shooting at a white target, a white fore sight with a black tip is perhaps the most easily defined. In competitions at Bisley every possible combination of black and white, dots and lines, has been applied to the fore sight of the military rifle. There is a necessity for some colour, even if it be only black, because when first issued the sight of the rifle is black, but a very small amount of rubbing polishes its tip and angles, which then reflect the light, and alter its appearance considerably if the sun comes out or goes in.

FIG. 65

The degree of importance attached by expert shots to the colouring of the sights may be judged from the fact that in the Swiss army the armourer of each battalion is supplied with a preparation for the express purpose of blackening the sights of all the rifles in his unit on mobilisation to take the field. The Swiss are a practical people, and they know the importance for correct firing of a sight which does not reflect the light. A black fore sight can be used perfectly well under ordinary circumstances for sporting purposes. It is not, however, readily discernible at all times. The object at which aim is taken is sometimes hardly different in colour from the background against which it is seen, and may be such that a dark fore sight cannot be outlined against it; in a fading light, or in the shade of trees, it is very easy to miss a shot, either because the proper amount of fore sight is not taken, or from the difficulty in directing the tip of the fore sight on to the exact spot desired. A white tip does much to remedy this, and facilitates a quick aim. The writer recollects, a good many years ago, a competition in which he thought it worth while to adopt a white fore sight. It was in the days when the Volunteer arm was still the Snider rifle. The conditions were to fire two shots at 200 yards at a black figure of the shape of a man's head and shoulders, then to run a certain distance, returning to the firing point to fire two more shots, and so on, for five minutes. He had come to the conclusion that a black fore sight would be a disadvantage, so he covered the whole of the barleycorn, that is, the cone above the square block of the fore sight, white, and found that the rapidity and certainty of his aim were decidedly increased. He won the competition, and attributes a large part of his success to this 'dodge.'

The fact that up till now the regulation target has been painted white has had a tendency to retard the proper appreciation of this part of the sighting question, in which the requirements of a military arm in the field differ hardly at all from those of a sporting weapon. Hans Busk, writing in 1858, and speaking of the bead sight, admits its advantages for target practice, but says that it is not well adapted for general use, especially for military purposes. He makes the following remark:—'It must of necessity be covered over by an arched shade, or the slightest touch would bend or break it off.' The idea of having the sight permanently protected by a hood affixed to the barrel is no new one. Mr. Charles Lancaster has a rifle of the Enfield pattern many years old, which is fitted with such a hood, and also with a special pattern of long-range sight, consisting of a graduated slide which folds underneath the wood of the fore end when not in use, and can be lowered so as to hang from it when it is desired to take aim. We should certainly like to see the British army provided with a rifle of which the fore sight should be to some extent bead-shaped, and with a white tip.

Of whatever shape the fore sight may be, it is always liable to damage from ill-usage. A fall upon stones, an inadvertent knock, will easily spoil the sights of a rifle. This is why hitherto the fore sight has been rather arranged for strength than for convenience. It is possible, however, to protect the sight to a very large extent, and it has long been the custom to give to the carbine, which has a low fore sight, strong projections on each side, rising rather above it. These wings bear the brunt of any hard knocks that are going. A Tyrolese modification of the same idea consists of two curved wings rising on each side of the fore sight towards each other, but not meeting, and so affording ample protection. This the writer has adapted with complete success to a sporting rifle (fig. 66). It is clear that a protection of this kind, which is always in place, and yet does not interfere appreciably with the aim, is of far more advantage than a detachable metal nose-cap. This has to be removed before the rifle can be fired, and carried separately; it is very easily lost, and very likely to be out of the way when wanted. There seems no valid objection to the use of a complete hood over the fore sight, if it is large enough not to obstruct the aim. But one important point must not be forgotten. The ease with which the fore sight is seen depends not only on its colour and form, but on its illumination. In firing at an ill-defined object on an obscure background, if the firer is himself in deep shadow, so that the sights do not get the light of the sky upon them, he will hardly be able to define his fore sight. A similar effect would be produced by a hood overshadowing the fore sight; and it is wise to cut away the top of the hood directly above the tip of the sight, in order to allow the light of the sky to descend upon it.

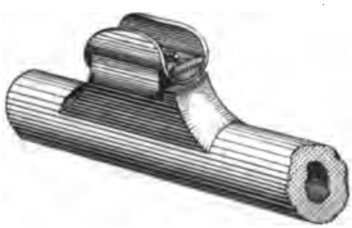


FIG. 66

The various fanciful forms in which back sights have been made for sporting and other purposes have often departed from simplicity to no purpose. The American buck-horn sight, which has a very deep notch and high curving sides, although it may to some extent enable the eye to centre the fore sight quickly, seems as if it were specially devised to obscure to the greatest possible extent the surroundings of the mark. Mr. Van Dyke has nothing to say in favour of it for sporting purposes, and from his own experience recommends a back sight of the very simplest form; merely a flat bar of some material that will not reflect the light, such as vulcanite, or hard leather soaked with ink. He does not think it any advantage to have a notch, but says that if one is required a very shallow one should be cut in the middle of the bar. The writer has found a very wide and extremely shallow hollowing of the whole width of the bar, with a decided but very small notch in the middle over a bright line, to make an excellent back sight for sporting purposes. Many illustrations of sights for sporting rifles are given in Mr. Gould's excellent book on 'Modern American Rifles,' published in 1892. He illustrates various forms of fore sights; among others, sights with ivory tips, bead sights (called by our American cousins pin-head sights), and different varieties of knife-blade and other fore sights. The ivory fore sight, which he recommends, and which has many excellent points, has in this country been superseded, for sporting rifles, by the bead sight, with white porcelain disc. The writer has found that an excellent makeshift sight can be obtained by filing the end of the metal bead flat, and at an angle of 45 degrees from the perpendicular, so that it reflects towards the eye the light from the sky above. A good back sight is a plain bar with a triangular ivory piece let into the face of it, the point of the triangle almost touching the edge of the bar and marking the centre. Every shape, size, and variety of notch has been at some time or another tried. A semi-circular notch, into the middle of which a bead is, as it were, fitted in aiming, gives not at all a bad combination. A form of fore sight, which can conveniently be used with a square notch in the back sight, is a plain square block, with a white line down the centre of it, or a fine saw-cut, which serves the same purpose, as it admits a line of light. The writer has a very high opinion of the Lewes sight (fig. 67) on this principle, which was fitted to the first issue of the Lee-Metford rifle. The square notch was cut of proper size to enable the whole block of the fore sight to be seen through it, with a small space beyond it on each side. The top of the block was levelled with the flat part of the back sight, and the point aimed at was seen just above the centre line of the fore sight. One of the chief faults of hurried shooting with the ordinary sights is a tendency to shoot high by taking too much fore sight. If time is not given for the eye deliberately to define the tip of the ordinary barley-corn fore sight, a considerable part of it has to be brought into view in order to be certain that it is seen at all. With the Lewes sight no such difficulty arises. The whole fore sight is seen in the notch of the back sight, and there is no tendency to see more of it than will bring its top level with the shoulders of the notch. The writer thinks it to be, for efficiency, decidedly ahead of the ordinary sights, but he believes that a white bead sight, made of good strength, and protected by a fixed hood so shaped as not to cut off the light from it, is a better sight for the military rifle than any yet adopted in this country.

FIG. 67

The most usual arrangement of the back sight in sporting rifles is to have a standing sight, with a V-shaped notch in it, for the shortest distance for which the rifle is sighted, and to have a series of hinged leaves fixed in front of it, any one of which may be raised when it is necessary to fire at a longer distance, as shown in fig. 68.

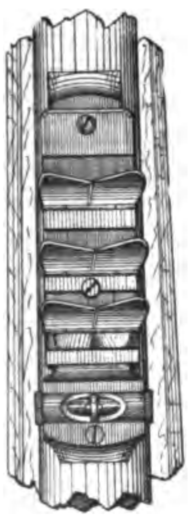


FIG. 68

Many are the devices which have been recommended for aiming in the dark. The writer once saw a company of officers under instruction at Hythe fire volleys in the dark with a surprising want of effect. Tape smeared with luminous paint was wrapped round the fore sights and back sights of the rifles, but it did not glow enough to be of any use until the rifles were well warmed with the firing, and this was not until the practice was almost finished. Small electric glow lamps have been suggested to take the place of the sights or to illuminate them; and sights pointed with diamonds have been recommended for sporting purposes. The difficulty of the problem lies very deep. If there be no light the sights cannot be seen at all unless they are illuminated artificially. But if this is done, then their very brightness prevents the eyes from seeing anything of the object at which they are directed. And here we must leave the matter: shooting in the dark can be little else but guesswork and fluke.

The chief difficulty of the eye in aiming is that it has to bring into line, and, so far as possible, to focus at the same time three points at different distances apart, the object aimed at, the fore sight, and the back sight. There is a natural tendency, which is not wholly without reason, to think that the further apart the fore sight and the back sight are the more correct is the aim which can be taken. But if the back sight, as ordinarily used, be placed too near the eye it becomes so badly defined, and so much blurred when the eye is fixed upon the mark, as to make accuracy of alignment difficult. This is why, in the Martini-Henry and in the ·303 rifle, the back sight has been put further forward than in the Snider, even though the barrel was shortened, and the fore sight brought nearer to the eye. Certainly the shooting which is made nowadays with our military arms shows that the sights are not so near each other as to spoil the results.

What means are there of obviating this want of definition of the back sight? Where the eyes are really beginning to suffer from the long-sightedness that comes with middle life, glasses are of much advantage, even if it is necessary, to a certain extent, to sacrifice perfection of definition of the target in order to bring the sights better into view; but there is one method which benefits all eyes, whether good or bad. If aim be taken through a small hole, which cuts off the rays that would otherwise pass through the outer part of the lens of the eye, points at different distances are defined with wonderful clearness. The principle was known long ago. Cross-bows of the sixteenth century are found fitted with a back sight, consisting of a blade with several holes in it at different heights, to give elevation at the different distances. It is probable that it was some real or fancied advantage of the kind which led to some of the earliest Continental rifles being fitted with a kind of small tunnel, two or three inches long, towards the breech end of the barrel, through which the fore sight was aligned upon the object. For target shooting the exactness of an aim taken through a small hole near to the eye has constantly been recognised.

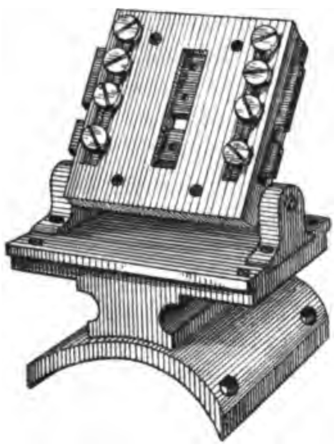


FIG. 69

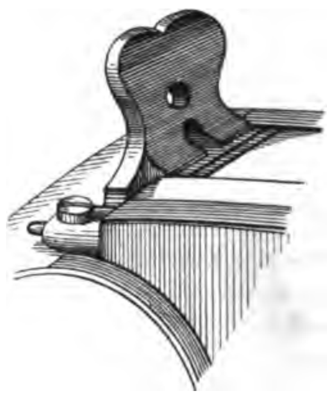


FIG. 70

We reproduce illustrations showing devices of the kind formerly in use, one from Colonel Beaufoy's book, now nearly a hundred years old, and one from a pamphlet upon 'Rifling and Rifle Sights,' edited by Lord Bury for the National Rifle Association in 1864 (figs. 69 and 70). The former represents a series of adjustable apertures for use at different distances; the latter, the back sight of an ancient rifle in the armoury of Warwick Castle.

Some of the various forms of sights which have at different times been tried must have been eminently dangerous in use. It is bad enough to have the vision of the aiming eye limited by looking through a very small hole placed close to it. But when the fore sight is also an aperture, in the middle of a metal disc, it is evident that the surroundings of the target must be so much obscured that there can be no certainty of seeing a danger signal, and very little that aim is taken at the right object. No wonder that such obstructive fore sights were condemned by the National Rifle Association as dangerous many years ago. The aperture back sight used in the Match rifle is of the kind illustrated in Plate XXXVIII, fig. 1, and has delicate vertical adjustments, the scale of elevation being graduated in degrees and minutes of a circle, of which the fore sight is the centre, and the distance between it and the back sight the radius. The method of measuring the elevation given by its angular value instead of by an arbitrary scale of inches and fractions, enables the same standard of sighting to be applied to various rifles of which the sights are at different distances apart, and gives a proper comparison between different loads used in the same rifle.

The back sight of the Match rifle is not usually fitted with any lateral adjustment to allow for wind, although a form of sight is made by Mr. Fraser, of Edinburgh, which can be moved transversely for this purpose. In the early years of the Wimbledon meetings many attempts were made to give such an adjustment to the back sight, but it was found simpler and more satisfactory to arrange the fore sight so as to slide laterally in a dovetail upon the turning of a screw. This is the principle generally adopted at the present time, the measurement of the wind-allowance being, like that of the elevation, made in minutes of angle. Plate XXXVIII, fig. 2, shows the complete fore sight ready to attach to the barrel of the ·303. The actual sight which is aligned upon the bull's-eye is usually in the Match rifle arranged in a little disc fitted in the body of the fore sight: the precise form of it varies according to taste. A very favourite shape, and one excellent for use at the target in a good light, consists of a little ring set upon an upright stem (Plate XXXVIII, figs. 3 and 4). The ring may be larger or smaller according to the taste of the user, but it must be so large, at all events, as to enable the bull's-eye to be seen through the middle of it, with a small circle of white surrounding it. Another sight, which is not so popular now as it was twenty years ago, is the calliper (Plate XXXVIII, fig. 5), two arms projecting horizontally towards each other, with an interval left between them in which the bull's-eye is placed. Another form of fore sight, which has not infrequently proved itself useful in a dull light, is some variety of what is known as the Goodwin bar (Plate XXXVIII, fig. 6), a straight horizontal bar with a vertical line in the centre, not unlike to the Lewes fore sight already described. This split bar (for the line generally consists of a cut down the middle of it) is used by placing it just under the bull's-eye, which can be done in fog, or even on a dark day when it is hardly possible to see the bull's-eye at all. Major Young preferred to use it with a small semi-circular notch, into which the bull's-eye fitted (Plate XXXVIII, fig. 7). The Goodwin bar proper, now very rarely used, is shown in fig. 71 in the text.

FIG. 71

We now come to the form of Match rifle sight which the writer has found the most satisfactory, and has used under all circumstances of rain or shine, not without some measure of success, for more than fifteen years. This is no other than the bead or pin-head sight, of small size and delicate shape (Plate XXXVIII, fig. 2). It is a sight almost more pleasant to use in a dull or bad light than in a very bright one, but yet in a good light no other sight will give better results. It requires, as does the ring sight, to be to some extent proportionate to the apparent size of the bull's-eye for the distance at which it is used. Major Godsal, who was one of the most prominent of British shots in the eighties, invariably used this sight. One clear advantage it has, that whereas the man who uses the ring sight will almost certainly have to change to another if in the course of his shooting the light becomes bad, he who is accustomed to the bead sight, and uses no other, does not require to disturb his habit of aiming by any alteration. There is certainly a great deal in accustoming the eye always to take exactly similar aim, because it thus becomes a matter of almost

PLATE XXXVIII

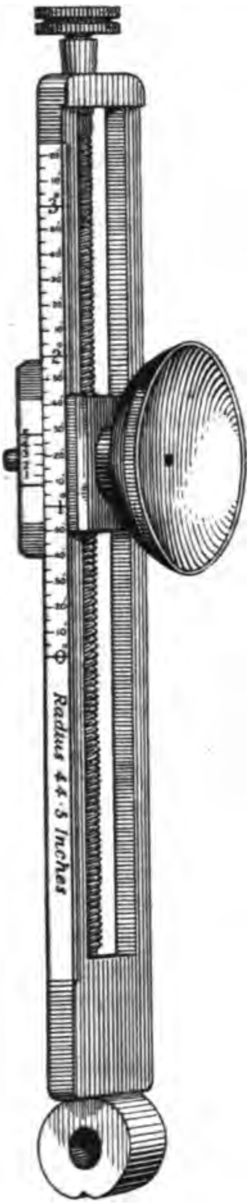


FIG. 1

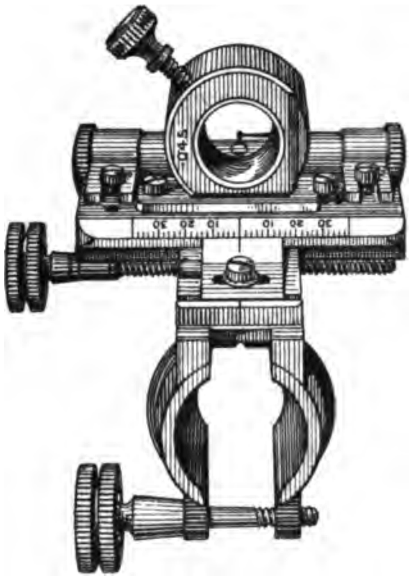


FIG. 2

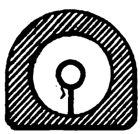


FIG. 3

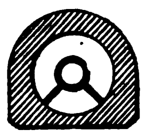


FIG. 4

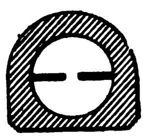


FIG. 5

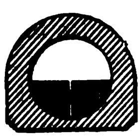


FIG. 6

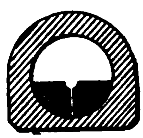


FIG. 7

mechanical habit, and makes the smallest demands upon the attention and the vision.

With the Match rifle, the bead sight is commonly placed upon the bull's-eye so as to cover it up, and when used in this way it should be of such a size as will just blot out the image of the bull's-eye. It could, in fact, be centred in the middle of a blank target with almost equal accuracy. Under certain conditions of light, as when the sun is behind the target, it is not always easy to define the outline of the target, and the bull's-eye alone remains visible. These conditions are very uncommon, and when they occur, good results may still be obtained if the bead, instead of being placed so as to hide the bull's-eye, is put alongside of it, so as to make a kind of 'figure of eight,' allowance being made for the distance between the centre of the bead and the centre of the target. Major Gibbs constantly uses the sight in this fashion. It was formerly common when the bead was used with the Match rifle to have it on an upright stem, but many now prefer to use it with the stem horizontal. The difference does not really amount to much, but, as the long-range target is twice as wide as it is deep, accidental inaccuracy that might give a miss vertically would probably not do so horizontally. By using a horizontal stem the outline of the target at top and bottom is not broken.

In all cases where adjustable sights are fitted, it is of the greatest importance to see that the slides or screws do not become loose, worn, or bent, as they are very apt to do. It is extraordinary how great a power the jar of the recoil has in loosening screws. The fastenings of the sights, of the stock, and of the barrel must occasionally be looked to; all moving parts must be kept oiled and free from dirt, and the greatest care exercised to prevent damage to them from blows, falls, or other accidents.

Timber, however old and seasoned, is always liable to warp, and the stocks of rifles form no exception to this rule. Where, as in the case of the Match rifle arranged for use in the back position, the back sight is fitted near the heel of the stock, and quite independently of the metal of the barrel and action, it is very necessary occasionally to check the correctness of the sighting. After the rifle has been put away, or exposed to the weather, it has often happened that the first shot has been thrown away owing to sufficient warping of the stock having taken place since the rifle was last used to make it miss the target at long range. Sir Henry Halford truly says:—'As the sights of a Match rifle are placed on the butt, the zeros should be verified occasionally, especially if the rifle has been exposed to wet or sun. A rifle stock should be, as far as possible, kept out of both, and never allowed to be on the ground exposed to sun or damp. It runs great risk of getting warped. A rifle, if put down when there is a hot sun, should be covered or put in the shade of a table or chair. Many a match has been lost by carelessness in this matter.' Nor is the effect on the sighting of the warping of the stock confined to the Match rifle. Where, as hitherto in the Service rifles of this country, the barrel is for almost its whole length laid in a long trough of exactly its own size and shape in the fore end, and held tightly to it by metal bands, any warping of the fore end, such as is in some degree almost inevitable at times, cannot fail to disturb the sighting of the rifle, and may materially injure the accuracy of the shooting.

There are many people who do not understand what a very flexible thing a rifle barrel is. After it has been first bored, and before it is rifled, its straightness is tested by inspection; it is pointed towards the top of a high window, when the outline shadow thrown by the light at once enables the practised eye to detect any unevenness of surface. A barrel which is not perfectly straight has its irregularities removed by a skilled workman with a few taps of the hammer applied at exactly the right spots. The heat of a lighted candle placed three or four inches below the barrel will at once produce an irregularity in the shape of the bore which is quite noticeable, and a little pressure with the fingers will also bend the barrel appreciably. It is not surprising, then, that a warped fore end may entirely upset the shooting of a very good rifle, and this is one of the points to which the attention of rifle-makers may well be directed. In one, at least, of the Continental rifles, the Swiss infantry arm, the stock is so arranged that the woodwork is in contact with the barrel only at the breech end, but leaves a space round it all the way to the point near the muzzle, where the nose cap is attached. Here the barrel has a collar of soft metal round it, which fits quite loosely into the hole in the middle of the nose cap. It is clear that however the woodwork may warp, it can hardly disturb the freedom of the barrel. The adoption of some similar arrangement in the British rifle will be a decided step towards improvement. It was formerly the fashion to regard the barrel of the rifle mainly as a strong stem on which the bayonet was to be fixed, but there is no reason why with modern rifles the bayonet should not be attached to the nose cap, and depend hardly at all on the barrel for its support. Enough has been said to show that barrels from which any degree of accuracy is required must be watched to see that they do not become wood-bound, and that the more care is taken to keep the wood from absorbing moisture, the less likely is it that trouble will arise from this cause.

With the ·303 rifle, the stock of which is in two pieces, being divided by the metal work of the action, one special caution is necessary. The butt is attached to the action by a strong screw reached by opening the trap door which lies in the heel plate, and removing the cleaner and the oil bottle, and a leather washer which lies beyond them; this exposes the head of the screw, which may be reached by a long screw-driver, and will commonly be found to be capable of being tightened if it has not been looked to for some time. It is curious how often even comparatively few shots will on occasion loosen this screw, and one of the chief difficulties of getting good work out of the Lee-Metford as a Match rifle lies herein. The writer has often found a stock appreciably loosened by twenty or thirty shots. On active service the loosening of the butt sometimes gives trouble. The British rifle is the only modern military arm which has a divided stock, and although if one part of it is split the other is not likely to be damaged, this hardly seems sufficient reason for not following in this matter the practice of other nations. The undivided stock is apparently cheaper and lighter, and seems to be strong enough to meet most requirements, though the wood is so cut away at the action that it is not very strong for bayonet work. It is no doubt owing to the clumsiness of the long wooden fore end that the Boers, who have no notion of using the bayonet, in many cases cut off the greater part of it, leaving only so much as was required for the grasp of the left hand. In the old-fashioned Match rifle the stock was similarly cut short, which both avoided trouble from warping, and enabled a greater weight of metal to be put into the barrel without exceeding the limit of weight allowed.

CHAPTER VIII

THE LYMAN SIGHT—ADJUSTMENT OF SIGHTS—HOW TO BLACKEN SIGHTS—ATTACHMENT OF LYMAN AND MATCH SIGHTS—THE ZERO OF THE SIGHTING SCALE—LONG-RANGE MILITARY SIGHTS—TELESCOPIC SIGHTS—THEIR ADVANTAGES—HOW FAR SUITED FOR MILITARY PURPOSES—THE INFRASCOPE

THE principle of the aperture sight has in these last years been applied very generally to sporting rifles for use at deer and antelope, where shooting is not at the shortest ranges. Like many other improvements in rifles, this developement came from across the Atlantic. The Lyman sight (fig. 72) is fitted just behind the action, so as to be within two or three inches of the eye, and consists of a pillar hinged so that it can be folded down either backwards or forwards. It has within it a stem which can be raised or lowered by a screw motion, and which carries at the top a small disc containing an aperture through which aim is taken. Usually the main aperture is comparatively large, and a small hinged shutter brings into place a much smaller pin-hole, which can be used for specially fine shooting, or when the light is very bright. There was a very strong objection to the use of a sight too close to the eye a few years ago. The Express rifle, with its large charge and heavy recoil, was apt to endanger the eye by driving back the sight against it. The comparatively small kick of the modern high velocity rifles has removed nearly all this danger, although care

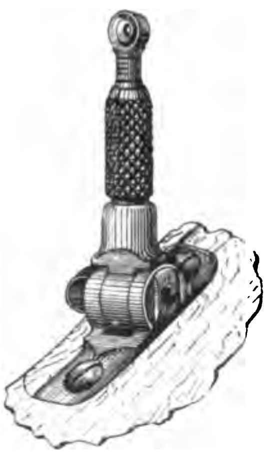


FIG. 72

still has to be taken that the eye is not put too close against the sight. The Lyman back sight is growing in favour for sporting purposes every year; it is pleasant to use, and there is no straining to be sure that exactly the right amount of fore sight is taken in the notch of a blurred back sight. This advantage alone has given fresh power to eyes beginning to suffer from the inevitable trouble which has been called 'annodominitis,' and for which there seemed to be no remedy but to use glasses, a great difficulty in a large proportion of days on the hill in some seasons, the sad alternative being the entire abandonment of stalking. The Lyman sight has not only the advantage of improved definition, but it gives a much freer view of the surroundings of the mark, since there are no shoulders of the back sight to obscure the aim, and this, especially for a running shot, is of considerable benefit. It is important to aim through the middle of the aperture, but the habit of doing so instinctively is very quickly acquired, and gives no trouble. Those unfamiliar with the use of this sight are commonly disposed to use too small an aperture; they think that there is a material advantage in using the smallest possible hole, but, in fact, there is no such appreciable advantage under ordinary circumstances; if the hole be too small, too much light is cut off, and there is a difficulty in seeing. For all purposes in the field an opening of between ·10 and ·05 inch will serve excellently well. The same principle applies to the Match rifle, although the aperture should hardly be so large as is permissible in the sporting rifle.

There is one objection to the Lyman sight, especially with bolt action rifles, when fitted on the small of the stock. When the bolt is drawn back to unload, it strikes the pillar of the sight, and knocks it down, and it has to be raised again before taking another shot. This could quite well be obviated by a spring arrangement, but spring fittings are liable to get out of order, and in any case when the rifle is in hands accustomed to manipulate it, the sight is raised again almost or quite without a thought. Various attempts have been made to avoid this slight inconvenience, but on the whole they are not satisfactory. The aperture sight can be placed upon the hinder end of the bolt, but the bolt, as a rule, does not fit very exactly, and it is difficult to be sure of the sight coming each time to precisely the same place, after the bolt has been opened and closed. Again, the sight has been fitted upon an arm hinged to the side of the action, and projecting over the bolt, but in this position it is unprotected and liable to damage. On the whole it is found worth while to face the slight inconvenience involved in placing the Lyman sight on the stock behind the action for the sake of the advantages of the aperture sight. With the falling block actions often used in sporting rifles, or with the ordinary action of a double-barrel rifle, this difficulty does not arise. The Lyman sight, excellent as it is for game shooting, seems difficult to apply to military or long-range purposes, as it would not be easy to adapt to it any adjustment to make an allowance for wind, nor is it well adapted for giving the wide variations of elevation required in the military rifle.

The fore sight used with the Lyman back sight may be of any description, perhaps the most satisfactory being a bead sight of moderately small size. To gallery rifles a bead which can be folded down, known as the Beach fore sight, is often fitted. The Lyman sight should be so adjusted that when it is screwed down to its lowest position the rifle is correctly sighted for the shortest distance at which it is to be used; this will be found to save many mistakes. It is important, as with all others, so especially with aperture sights, that they should shoot correctly to their aim in the hands of the individual who is to use them. It is very commonly found, in fact it is the case more often than not, that rifles as delivered to the customer do not shoot to his aim with perfect accuracy. One of the factors in the success which Messrs. Holland have had with their rook and other rifles has been the great care with which they were sighted so as to be correct for the average man. For this they owe a great debt to Mr. W. G. Froome.

But there is no adjustment of sighting so satisfactory as that which is made by the shooter himself, and it requires to be done with care and some small amount of knowledge. In rifles in which the fore sight or the back sight, or both, are fitted in a dovetail slide, so that they can be removed transversely, it is easy to adjust the sights for direction. It is very natural to take a small hammer, and knock the slide, and drive the sight to one side or other with it; but it is better to interpose a little piece of hard wood, or of brass or some soft metal, between the hammer and the sight base, as otherwise this is apt to be bruised, and a careless blow may even damage the sight itself. It is sometimes advisable to adjust an open sight, enlarging or altering the shape of the notch of the back sight with a fine file. It is very necessary to be careful to file away that side of the notch which will make the correction; the writer has known a man puzzled because the shots went wider instead of straighter, as he altered the back sight, when he was really cutting away the wrong side of the sight. After any alteration shots should be fired, not only one or two, but at least five or six, in order to obtain a group, which will show the general line of shots; if only one or two shots are fired, these may be slightly abnormal, and so prove misleading.

When it has been necessary to file the back sight (we are speaking, of course, only of the open back sight, and not of the aperture sight), it is very necessary that it should be blackened again, to prevent the glinting of the light from misleading or dazzling the eye. The smoke of a match, or of a piece of camphor, will do this for the moment. Major Young, in his excellent little book, 'The Three Rifles,' gives a recipe for making a temporary dead black as follows:—

'*Temporary Dead Black.*—A capital black may be made at a trifling cost; it is far superior to what is sold. It is made thus:—

1 oz. "stick-lac" . . .	cost about	3*d*.
1 oz. vegetable black . .	„	0½*d*.
6 oz. methylated spirit . .	„	6*d*.
		9½*d*.

Dissolve the "stick-lac" in the methylated spirit (it takes about a week to melt thoroughly), then strain it through muslin, and add the vegetable black, shaking up the contents of the bottle to insure a thorough mixing. It may happen that owing to slight differences in the materials, a little more or less than the stated quantity of the vegetable black may be necessary. This must be judged by the consistency of the mixture when applied. Cork it down tight, and fill a small bottle from time to time, as required for immediate use.'

This is a very tenacious compound, and does not by any means rub off with a touch. Major Young's recipe to blacken permanently sights which can be removed from the rifle is an excellent one, and the author has used it with success for the sights of sporting rifles. The nitric acid, of course, requires great care in use and in keeping.

'Take of nitric acid 1 part, and of water 7 parts, thoroughly mix, and the solution will be ready for use. Detach from the rifle the part that needs to be operated upon, and with a fine piece of emery cloth thoroughly brighten the surface. Place the piece of metal in boiling water (a tea-cupful), to which a pinch of bicarbonate of soda has been added, and stir it about briskly with a piece of iron wire, glass rod, or stick. After a few minutes pour off the water, and add more boiling water without soda ; treat as before, and drain off the water. The object of this process is to remove all trace of *grease*, which is an enemy to perfect success.

'Take of the nitric acid solution as much as will thoroughly cover the sight or sights that have to be blackened—an old wine-glass, damaged coffee-cup, or any such vessel answers admirably for holding the acid mixture. Drop the sights in one by one, being careful that no two get into close contact, as it is necessary that the acid should have free access to the surfaces. After a few seconds the bright polished surface will assume a dull leaden look, and the fluid will become slightly discoloured immediately around the metal. Gradually the smooth look will give place to a *finely pitted* appearance, when the sight should be turned over. In about three minutes the action of the acid should have been sufficiently marked, when the sights must be removed, being dragged out with a hairpin or wire; at once plunge them into a small vessel filled with *boiling* water (an empty salt jar is as good as any vessel). Stir them about briskly, pour off the water, and fill again with *boiling* water; allow them to remain in about five minutes; now remove them, and put them to *boil* in an old saucepan for 15 or 20 minutes, in order to kill every trace of acid. If the washing be hurried over, the chances are that red spots and streaks will appear in the next step.

'After wiping the sights with a dry cloth, proceed to blacken as follows:—Twist a piece of iron wire round the sight, to manipulate with; hold it in a gas flame, and carefully watch the colour. At first it will turn straw colour, then brown, after that dark brown, and lastly a bluish colour, when it should be removed and plunged into oil (salad oil, so called, answers well). If allowed to pass the bluish colour it will become white with heat, and this is undesirable. After allowing it to cool in the oil, remove it, and the black ought to be "dead"—*i.e.* not shining—due to the finely pitted surface breaking up the light that might otherwise be reflected.'

In affixing the Lyman sight to a rifle it is important that it should be upright, and, of course, it must be in true central line. When the base has been affixed by its screws as nearly as possible in the centre, if the sight shoots a trifle to one side, and it is not convenient to move the fore sight (as, for instance, when the Lyman sight is added to a rifle which already has the fore sight and the ordinary back sight in proper adjustment), the Lyman can be brought finally into line by placing a narrow strip of brass foil or paper under the edge of the base on one side or the other, after loosening the screws so that when they are tightened up again the pillar will be tilted a little to one side or the other.

In adjusting the sights of Match rifles much care is required. The rifle should be held in a vice, with cork jaws, and the fore sight attached and put properly into place. The rifle should then be moved, if necessary, until the spirit-level on the fore sight shows it to be upright. The back sight, which we assume to have been fastened provisionally in place, must now be tested with a level set on a square, to see that it is truly upright, or, if inclined at all, inclined very slightly to the side which will tend to compensate in some degree for the drift of the bullet. It is well to ensure a proper fit between the bed on which the sight is hinged and the part of the stock upon which it fits by scraping away the stock until the bed is solidly in contact with it. If the sight is not upright a little more scraping one side or the other will probably bring it so. Where a large amount of adjustment in this respect is needed, packing on one side or the other may be resorted to, but it is better to get a proper fit if it can be done. The rifle will then require shooting to test the straightness of line of the sights with the barrel; and the position of the fore sight which gives straight shooting is marked upon it, and used as the basis for wind allowance to one side or the other, the same being done as regards elevation with the back sight. The elevation scale on the back sight of a Match rifle has a vernier scale by which the elevation can be correctly set to half a minute of angle or less. The best match sights are fitted with an adjustable zero. This is a small sliding piece, which can be fastened with binding-screws, and which carries the zero mark (*i.e.* the basis of the scale of elevation or wind allowance), so that it can be shifted to suit the peculiarities of the particular rifle upon which the sights are fitted, or to rectify any incorrectness of elevation or direction that may arise during the life of the rifle, whether from the warping of the stock or from other causes. Such variations in a small degree are constantly arising, and it is commonly found that when two rifles are being shot alongside each other, with careful comparison of the allowance for wind, the relative shooting of the rifles will not remain precisely the same for any great number of shots together. Though probably this is in part an apparent effect due to the deviation of the individual shots from the general group which each rifle is making, it is certainly in part due to actual fluctuations of sighting, that is, to temporary differences between the line of the sights and that in which the bullet is delivered from the barrel.

Following the example of Mr. Metford and Sir Henry Halford in this matter, the writer is in the habit of checking the correctness of the setting of the sights of his match rifles occasionally at the short distance of 12½ yards. Those accustomed to big guns have sometimes criticised the use of so very short a range as this on the ground that the bullet has not settled to its true flight at so early a stage. But there is practically nothing in this idea, as is proved by the fact that there is no difficulty in adjusting the zero, or basis of sighting, both of the vertical scale on the back sight, and of the horizontal scale on the fore sight, correctly to 1 minute of angle at this distance. The advantage of the use of so short a distance is that it gives a correct basis both for elevation and wind allowance, without the complications introduced by varying conditions of wind and weather which make it difficult to correct the sighting at 500 or even at 200 yards. In shooting for zero at 12½ yards, a small spot, about ½ in. in diameter, is made upon a piece of cardboard, or, better still, one, or two, or three rows of spots may be placed upon it about 3 inches apart; it is convenient enough to punch out these spots with a wad punch. Very careful aim should be taken, with the sights adjusted to what appears likely to be the right place, and a general correction can at once be applied to bring the bullet about to the right place. At 12½ yards 1′ of angle is equal to ⅛ inch on the target, and as the scales of the back sight and fore sight are marked in minutes, any desired alteration can quickly be made. It is necessary to know precisely the vertical distance of the fore sight above the centre of the bore, since the zero point has to be that at which the line of sight and the line of projection of the bullet are absolutely parallel. If the fore sight be 1 inch above the centre of the bore, the bullet, when the sight is correctly placed, would strike just 1 inch below the centre of the spot aimed at, with the addition of the distance which the bullet falls during its flight of 12½ yards. This amount varies to some small extent according to the speed of the bullet. With the old Match rifle of ·450 bore, and a velocity of about 1,300 f.s., it was about ⅛ inch, and it will be near enough for practical purposes with the Lee-Metford, if we say that the fall due to gravity at the speed of 2,000 f.s. is ·06 inch. This amount, then, requires to be added to the 1 inch already mentioned representing an allowance for the height of the fore sight above the bore, so the centre of the shot should strike 1·06 inch below the centre of the spot aimed at for elevation.

The point thus obtained will represent the basis on which the scale of elevations for all distances at which the rifle can be used can be built up.

In sighting military or sporting rifles, the sights of which have not the same degree of universal adjustment as those of the Match rifle, it is only necessary to correct the sighting at one particular distance. This then serves as a basis, as regards direction, for the other distances, the proper elevation for them being determined by experiment. This may be done without going to each distance if a table of angles is available. Thus in sighting a ·256 sporting rifle at 200 yards, if it is known that with the particular rifle and charge used, the rise in elevation between 200 and 300 yards is 4·8 minutes, it is evident that if the 300 yards sight be adjusted so that it shoots 9·6 inches high at 200, the elevation with that sight will be correct at 300 yards. In this way the sighting can be correctly given for a whole series of different distances without actually going to them.

The ordinary sights of the ·303 rifle give elevation up to 1,800 yards, and special long-range sights (Plate XXXIX) are attached to the side of the rifle, and can be used from 1,600 to 2,800 yards. The principle of the aperture sight is applied here, the back sight consisting of a thin stem carrying a small ring, which is fixed to the metal work on the left of the body of the rifle, and when not in use lies in a recess in the stock (fig. 2). The fore sight is shown in fig. 1. It is attached to the woodwork just behind the lower band, and consists of a dial and a pointer, the opposite end of which carries a small bead. The pointer may be turned to any of the marks indicating the different ranges which are inscribed on the dial, and moves very nearly a complete semicircle, so that a very wide range of motion is obtained for the bead. This sight is of a very rough and ready kind, and could probably be improved; it cannot be depended upon in any given rifle to give a line parallel to that in which the rifle shoots, but on an emergency it has undoubtedly done good work.

It will be noticed that in the use of the aperture back sight as here applied the necessary conditions are all met.

PLATE XXXIX

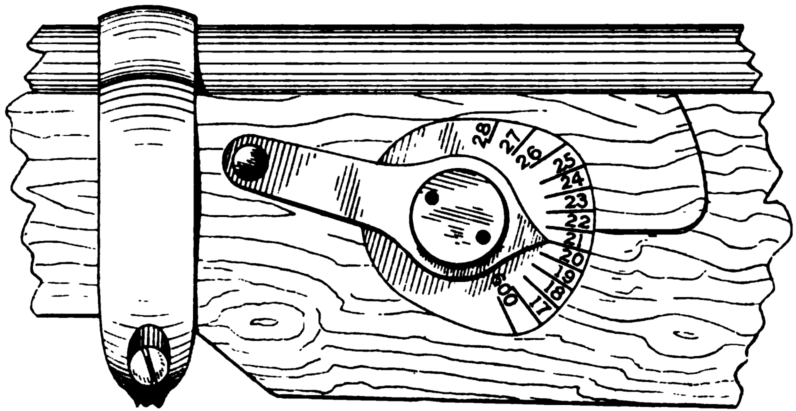


FIG. 1

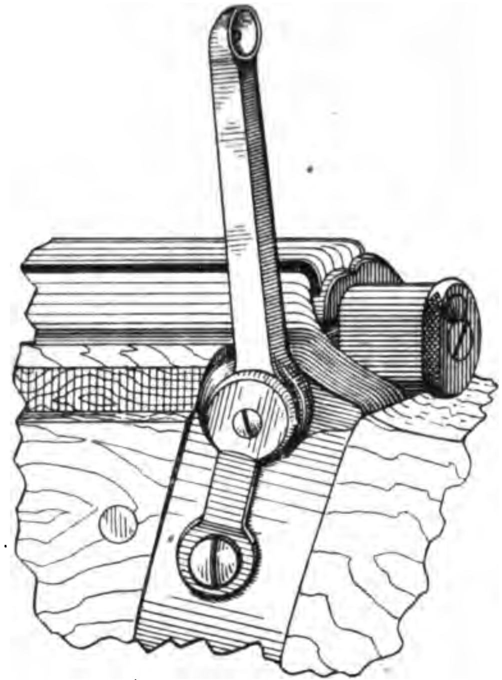


FIG. 2

It is placed conveniently for the eye, and does not require any adjustment for elevation, this being made by raising or lowering the fore sight.

It seems probable, so far as the Boer war may be taken as a guide for future campaigns, that fire at very long distances will be more used in future than hitherto. It will always be impossible, so far as we can tell at present, to make a small arm which will give its bullet an absolute accuracy of flight at long range, and enable, let us say, a single man to be struck with any certainty at distances of a mile or more ; but now that the number of shots which can be fired in a given time from a given number of rifles is so enormously increased, it is possible at very long ranges to inflict loss by dropping a large number of shots in a small area. To shoot at a single man at such distances as those of which we are speaking demands, in the first place, that it should be possible to see him. The South African climate seems exceptional in this respect, but there are times when even our own foggy air will permit of bodies of troops being seen a very long way off. There is one means of obtaining great advantages both in discerning the object and in taking accurate aim at it which in this connection it seems worth while at the present time seriously to consider. The telescopic sight rests on very simple principles, and under certain circumstances has proved itself a very practical addition to the rifle. It consists in its essence of a telescope, of no clumsier proportions than can be helped, attached parallel or nearly so to the barrel of the rifle, and having in its field cross hairs or a pointer to define the point of aim. If the telescope has been adjusted properly for the distance, nothing remains to be done but to place the aim point exactly upon the mark seen in the field of the telescope, and to pull the trigger steadily. All the effort to the eye of aligning three points—the back sight, the fore sight, and the mark—which are at different distances, and therefore in different foci, is at once removed. The picture seen by the eye is in a single plane, the pointer or cross hairs being quite as much in focus as the distant object. Such sights have been of late years applied both to large cannon and to field artillery, and enable full advantage to be taken of the very great precision with which they project their shot.

The telescopic sight when applied to the rifle is undoubtedly a very practical improvement under certain conditions. It was so applied in this country a hundred years ago. It has long been used in America for the sport (not uncommon there, though unknown here) of making the finest possible diagram at some such distance as 200 yards, with every possible assistance of rest, hair trigger, and an unlimited waiting for weather between the shots, which art and ingenuity can suggest. In this country the National Rifle Association have until recently discouraged its use, and with good reason, since the fine aperture sights as fitted to the Match rifle give practically as good results at the target as can be obtained at long range with the telescopic sight. It is of little use to aim accurately (say) to a quarter of an inch, when the general deviation of the group is perhaps six inches. But delicate aperture sights, with their adjustments, are not suited to the rough work of use in warfare or in the chase. In America the telescopic sight has long been used for other purposes than target shooting. An interesting chapter on the subject in Mr. A. G. Gould's book on 'Modern American Rifles' shows both the respectable age of the use of telescopes on the rifle, and also that they have proved of very great advantage in skilful hands when attached to sporting rifles. He mentions that short telescopes were used many years ago by turkey shooters, but the results were not satisfactory. During the Civil War in America a number of Whitworth rifles were shipped from England for the use of the Confederate sharpshooters, and these were fitted with telescopic sights of the pattern invented by Colonel Davidson, which is illustrated in Lord Bury's pamphlet of 1864 already referred to, on 'Rifling and Rifle Sights.' In Plate VI, fig. 3, is given an illustration of a Whitworth rifle fitted with the Davidson telescope, dating from this period. In Lord Bury's pamphlet illustrations are given of an American telescopic sight belonging to Mr. Metford, and designed by Mr. J. R. Chapman, C.E., in America, and made by James, of Utica. There is also a complete drawing and description of a telescopic sight apparently of better design than either of these, invented by Mr. Metford, and of the type which he used for many years for experimental work. The American telescopes were usually made of the full length of the barrel of the rifle, and placed directly over it, as may be seen in Plate XXII. The Davidson and Metford telescopes were far shorter, and arranged to one side, there being a great difficulty in giving sufficient elevation for long ranges if the tube of the telescope be a very long one. Mr. Metford used telescopic sights of his own design as early as 1854, but the bulk of his long-range experiments were done with the ordinary Match sights. Mr. Gould speaks of a considerable demand for the telescopic sights made by Malcolm, of Syracuse, who improved those of his day, and after 1870 many hunting rifles were fitted with them. He quotes a letter from a sportsman living in California, who had a very high opinion of the telescopic sight for game shooting, one which was shared in and acted upon by many of his friends in the same part of the country. Little is said of the advantages for hunting purposes of the telescopic sight, but clearly they have been found to be considerable by some of those very well qualified to judge.

Besides the assistance to the eye already mentioned, and that which must in some degree arise, though it is not usually material at sporting distances, from a more accurate aim, the chief advantage of the telescopic sight lies in the increased visibility of the object fired at. The writer has himself on occasion killed rabbits in the dusk of evening, when, without the telescope, he could not be positive that the object he saw was a rabbit, and when the attempt to align the open sights upon it blotted it out entirely. It is a great advantage, where the object fired at is difficult to define, or perhaps only partially seen, to get a better view of it than the unassisted eye will give.

The black and white target commonly used for rifle competitions is the mark at which open or aperture sights can be used to the greatest advantage. In war and in sport the conditions are changed. There is a real advantage in being able to see through the tree trunks which part of an animal a patch of brown hide belongs to, or in discerning exactly how and exactly where a half-concealed enemy is crouching, while to define distant objects of no great size (and the human figure becomes very small to the eye at distances of over half a mile) the advantage is even greater.

To whatever kind of rifle they may be fitted, telescopes should possess the qualifications of strength, lightness, and compactness. The field of view should be as wide as possible to avoid any difficulty in getting a quick sight of an object hard to find in its surroundings, or even one that is moving. There is no advantage gained by reducing the field in order to get a very high magnifying power. The field should be well lit, and the definition, especially in the centre, must be as good as possible. The lenses and all other fittings of the telescope must be solidly fixed, so as not to be shifted by the recoil or by a blow. The telescope should be so arranged that, while it comes into a convenient position for the eye, its recoil can inflict no injury to the face. It is well to set back the object-lens some little distance into the tube, so that it may be sheltered from the sun and wet.

For general purposes it would seem that a power magnifying about 4 times is as high as is useful, although, if the object be only to make fine shooting at a target, a large field is not required, and the magnifying power may be considerably more than this. With the sporting rifle, the sighting of which does not need to extend beyond 300 or 400 yards at the very outside, the elevation necessary is best given without any shifting of the tube. A diaphragm of glass, upon which a vertical line and a horizontal one are engraved, may be placed in the focus of the eyepiece, and the intersection of these lines gives the sighting for, let us say, 100 yards; two or three other horizontal lines engraved below the first will give the elevation for 200, 300, or 400 yards, and the eye can select the proper line in aiming any particular shot. It would be possible to extend this principle so as to give sighting for a considerable distance, but when the lines are too many, and when, as must often be the case, shots have to be fired under circumstances of hurry or excitement, it is very easy to make a mistake and pick the wrong line. This system, therefore, is hardly suited for military or even for long-range target rifles, and it is better to have some form of mechanical adjustment of the whole tube of the telescope to give the required elevation, keeping the single-aim point of crossed threads or of lines engraved on glass, so that, whatever elevation is used, the aim is always taken in precisely the same way.

Mr. Gould describes an invention for giving elevation for a long-range target rifle by inserting in front of the object glass prisms cut to different angles, and so altering the direction of the rays, and in this way obtaining elevation. A similar contrivance was used by Mr. Metford in the telescopic sights on the rifles he made to compete for the National Rifle Association prizes at 2,000 yards in 1865 and 1866. He used it in order to remove the inconvenience to the head and eye of having to aim at an angle very different from that in which the barrel was pointed, but the final adjustments of elevation were given by moving the whole tube. It may be possible to devise an arrangement of prisms by which the elevation can be adjusted as desired without moving the tube of the telescope, and such a system as this, if practicable, would solve many of the mechanical difficulties which arise when the whole telescope has to be shifted.

An interesting competition, organised by the National Rifle Association, took place at Bisley in 1901 with telescopic sights fitted to the Service rifle. The target, though having the ordinary divisions of a long-range target marked upon it, was so painted as to be very difficult to define with open sights against the stop butt behind it. The following conditions were laid down for the telescopic sights: The field was to be not less than 6°, the maximum weight of the telescope with its elevating gear 1 lb., its greatest length 9 inches, dimensions which give a fair margin if compactness is really aimed at; and it had to be so fitted as to give elevation for all distances to 3,000 yards. It had to be capable of being almost instantaneously attached to or detached from the rifle, so that it might be carried separately. The scoring made under these conditions was not higher than that made on the ordinary targets, having a visible bull's-eye, with the ordinary sights; but it may be doubted whether on a target so difficult to see as was that actually used it would have been possible to make very accurate shooting without magnifying power.

The chief difficulty in designing an adjustable telescopic sight is due to the strain put upon all its joints and fittings by the recoil. There are two systems upon which a telescope can be fitted to a rifle. One is to incorporate it, so far as possible, with the barrel, as has been done in American rifles, or to attach it at the side so that it is practically irremovable. The other is to accept it as a principle that the telescope should be carried separately, and only attached when it is likely to be wanted. The latter method is the only one which is applicable to military rifles. Telescopes attached to the side of the rifle, as in bolt-action rifles it is inevitable that they should be, cannot be ensured against damage if they are constantly on the rifle. It is better to make them as small and as light as is possible consistently with strength, and to have such an arrangement for affixing and detachment as may enable those operations to be performed almost instantaneously. But there must be no fitting on the rifle which is in the way or liable to damage, and the attachment must be such as will not easily become loosened by wear. Dr. Common and Mr. Mallock, C.E., have given much attention to the production of a telescopic sight fulfilling the various requirements here stated. The writer has on a sporting rifle a telescopic sight designed by the latter gentleman: the tube of the telescope is only 8 inches long, and is conveniently carried in a little leather case on a belt. A great advantage of having the telescope attached on one side of the rifle is that the ordinary sights can be used equally well whether the telescope is on or off.

It is evident that in South Africa effective fire has been brought to bear from rifles at distances beyond those usually contemplated, and also that in fighting a civilised enemy every device of concealment and of taking cover has to be resorted to, which makes it difficult for the enemy to be seen, and an effective reply given to his fire. In the hands of a properly trained and intelligent soldier it is quite possible that the results which could be obtained in increasing the effectiveness of fire at all distances might make the telescopic sight well worthy of adoption as an adjunct, for some small proportion of the men, to a military rifle. Yet the telescopic sight cannot altogether supersede the ordinary sights, since it is useless in rain and of little advantage in mist. The number of shots fired in South Africa for every casualty caused by them must be something incredible, and in these days of rapid loading, when ammunition is so very easily wasted, whatever really increases the effectiveness of fire, so as to enable the same result to be obtained with fewer shots, is a great economy and a great advantage.

It is an interesting speculation how far, as war becomes more scientific, it will be possible to teach the soldier to use scientific appliances. The spread of education has certainly done much, more, perhaps, than has as yet been realised, to remove the necessity for treating Tommy Atkins as if he required dry nursing and spoon feeding at each instant of the day, and was not to be trusted as a reasoning being in any particular. Wars will in future be won, if we may judge from South African experience, by the intelligence of the rank and file quite as much as by their bravery.

A little device may be here mentioned which is the outcome of the Boer war, and more especially, it is said, of the siege of Mafeking, called the 'infrascope.' It seems clear that in firing from entrenchments against our advancing troops in more than one battle, the Boers found the storm of shot and shell directed against them so overwhelming that they held up their rifles over the edge of the entrenchment, and discharged them in the general direction of the enemy without attempting to take aim. Even such a fire as this has a degree of effectiveness. At Mafeking, where the trenches got to very uncomfortably close quarters indeed, the fact that Nature has placed the human brain above the human eye was sometimes found to be inconvenient, as the part of the head which the enemy saw when he was being fired at was sufficiently large to form a good mark for him. An impromptu device was arranged to enable an effective fire to be brought to bear under such circumstances. Two small pieces of mirror were attached so that one could be clipped on behind the back sight, while the other hung down below and to one side of the rifle, and in the latter could be seen the reflection of the line of aim shown by the former. This enabled shots to be truly directed while the whole head of the firer was below the sheltering level of the sandbags or earthwork protecting him. The application of this arrangement could hardly be very extensive, since it admits of no large field of view, but under special circumstances it has proved its utility. We may, perhaps, hear of it again in the future, when entrenchments have to be defended. It might conceivably be of advantage on occasion to use such an aid in stalking animals, but we do not think that the sportsman's spirit of fair play would approve of it, even if the occasions on which it might be useful were likely to be other than quite exceptional.

CHAPTER IX

AIMING—TWO-EYED SHOOTING—AIMING AT A TARGET—USE OF THE BAR SIGHT—WIND-GAUGE SIGHTS—MENTAL AND PHYSICAL CONDITION—TOBACCO AND ALCOHOL—LATERAL ERROR FROM CROOKED SIGHTS—THE SPIRIT LEVEL—FIRING UP AND DOWN HILL—HIGH-ANGLE FIRE—TERMINAL VELOCITY

To learn to align the sights correctly is not quite so easy a matter as might be supposed. Even what is laid down in military works as one of the most important rules of aiming, that of closing the left (or non-aiming) eye, is a rule the need of which is in no wise universally acknowledged. Much has been written and many different opinions have been maintained as to the advantage or otherwise of aiming with both eyes open with the rifle. That this is the proper method with the shot gun is in these days universally acknowledged, but there is just this difference between the gun and the rifle, that with the latter absolute accuracy of aim is demanded, while with the former the aim need only be approximately correct. The matter is hardly so complicated as it is sometimes made out to be. If one eye be closed, and the sights aligned upon the mark with the other, no difficulty or confusion of vision is experienced. If the other eye be opened, and also focussed upon the mark, there is conveyed to the brain a second image of the barrel and the sights situated to one side of the line in which the mark is seen by the non-aiming eye. This will be clearly observed if the aiming eye be momentarily closed. Just as by dint of habit and long usage the right hand becomes better educated than the left, and is without special thought set to do any work requiring the smallest skill, so the eye habitually made the most use of is that naturally used in taking up an alignment. This eye is commonly known as the master eye. It has often happened that sportsmen have shot for years with the gun from the right shoulder with very little success, and at last found that they were aligning the image of the muzzle, or the bead upon it, as seen by the left eye, with the mark, it being absolutely certain that in doing this the general line of the barrels must be pointed clear away from the mark, and that no success in shooting is possible except by a fluke. In such cases the alternative remedies are, either to shoot from the left shoulder, or to have the gun made with a crooked stock so that, though fired from the right shoulder, the barrels come into place and are aligned upon the mark by the left eye. If the right eye, though not the master eye by habit, have good sight, the left eye must either be closed or bandaged, or else some kind of small screen must be interposed in front of it so as to prevent its having a view of the muzzle of the gun or rifle. Fifteen years ago a controversy on the subject of two-eyed shooting was carried on in the columns of 'Land and Water,' nor was this by any means the first time that the subject had been argued. Mr. Gilbert proposed to deal with the difficulty by attaching to the left side of the weapon a little leaf which blocks the vision of the left eye, and which he called a 'shooting corrector.' It has been pointed out that a high thumb-stall upon the left hand will effect the same object, that of hiding the fore sight from the left eye, without interfering with the vision of the mark by either eye, and any such device has a distinct utility in certain cases. The same difficulties occur in rifle shooting. It is found convenient to instruct the recruit to shut the left eye in firing so that his sight may not be confused by the double images set up, and that he may not be tempted to use the left eye even if it be the stronger. It would not seem to require much proof that, when Nature has provided a screen for the eye in the shape of a lid, it is normally better, if a screen be necessary, to make use of that than to complicate the weapon by affixing to it an artificial screen to serve the same purpose. But if the right eye be very definitely the master eye, there is no need after a reasonable amount of practice to close the left eye. Formerly, when he had time to shoot regularly with the military rifle, the present writer with some difficulty formed the habit of keeping the left eye open while aiming. The target gains much in illumination and clearness by being seen with both eyes, while the sights aligned upon it, though seen only with one eye, are sufficiently well defined to admit of very accurate work.

Ezekiel Baker a hundred years ago came to the same conclusion. He says: 'In presenting and taking aim, it is far preferable to open both eyes, as the object is sooner attained, and the sight more perfect: it also prevents that blinking which is a general case in shutting one eye. This may be difficult to many at first; but "practice makes perfect"; and when it is once accomplished, the advantages will be sufficiently evident. From my former observations many persons have tried the experiment, and have since declared that, having accustomed themselves to keep both eyes open in taking aim, they are satisfied that this method is the best, and that in every instance it has had the desired effect.'

Mr C. F. Lowe, who has for many years been a conspicuous figure at the meetings of the National Rifle Association, and who is a great advocate and exponent of two-eyed shooting, has pointed out that with both eyes open it is very possible to do reasonably good work with the rifle if a collar of paper is fastened round the muzzle in front of the fore-sight, so that while the right eye sees the two sights in line it cannot see the mark, but the left eye has a clear view of it. When by the general vision of the two eyes every detail of the whole picture seen is fitted into its place, the target or mark seen by the left eye appears as if seen by the right eye through the paper collar, and the sights can be correctly aligned upon it. In an exactly similar way most sportsmen in shooting at a pheasant coming overhead directly towards them absolutely cover the image of the bird with the muzzle of the gun, but, because the left eye still sees the bird, are able to know how far in front of the bird they are pointing the gun, and so to give the proper allowance and direction. The effect conveyed to the brain is that the right eye sees the bird through the gun barrels.

The physical and the mental machinery of human beings differ so much in particular instances that no rule can be laid down as to two-eyed shooting. To those who find that they can keep both eyes open it will be on the whole an advantage to cultivate the faculty. Probably some perseverance will be needed before they properly develope it. But there are many very successful shots who do close the left eye, just as there are many who do not. To keep the left eye open is certainly to avoid the small amount of muscular strain on the upper part of the face otherwise involved, while the view of the surroundings of the target is maintained almost undiminished.

Whether with both eyes open or with one of them shut, the beginner has first to acquire the habit of seeing the fore sight precisely over the centre of the back sight, and of taking each time precisely the same amount of the fore sight. This must be practised until it becomes a mechanical habit. Our military rifle is, when quite normal, correctly sighted for any distance when the back sight is raised to the mark for that distance, and the top of the fore sight seen in the centre of the V, and on a level with the shoulders of the V (fig. 64, p. 220). Some consider that the simplest thing to teach is that the tip of the fore sight thus seen should just cover the object to be hit. The writer believes this view to be fallacious, and with the sporting and the military rifle alike prefers to have the sighting arranged so that the point to be struck by the bullet is just touched by the tip of the fore sight. It is a sound principle that the object to be hit should never be obscured, as it must be if it is small, and if, in order to obtain the correct elevation, it has to be entirely covered by the fore sight. There are many ways of aiming at the ordinary white target with the black bull's-eye on it. It is not satisfactory always to aim at the bottom of the bull's-eye, because this means that the group of shots has to strike decidedly higher than the point aimed at; and at different distances, at which the proportions of the bull's-eye vary, different degrees of allowance have to be made. Nor is it very easy always precisely to touch the bottom of the bull's-eye with the tip of the fore sight. In some lights, in which the bull's-eye is comparatively grey, no difficulty arises, but in a strong light it may appear as black as the fore sight, and then it is difficult not, as it were, to stab the point of the fore sight into it, instead of merely touching it. A favourite means of aiming, for which there is much to be said, is to place the fore sight so that it touches the edge of the bull's-eye at what, if we consider it as a clock face, would be nine o'clock or three o'clock, making a slight allowance to bring the shots into the centre of it. By this means the elevation is maintained without difficulty. Some men make good shooting who have the habit of hiding the bull's-eye entirely with the fore sight. Another mode of aiming upon the white target in ordinary use, one practised by not a few, is to aim at the top edge of the target. If this be done, there is no difficulty in keeping the elevation, while the eye can judge very accurately the centre of the target, and allowance for wind can be very correctly made to the right or the left within the limits of its width. That this method is capable of giving very good results many successful prize-winners can testify. For all that, it is too artificial for the writer's taste, and he does not consider that a system which depends so entirely upon losing sight of the object which it is desired to hit, and upon the fact that the ordinary target is white, and is bounded by straight lines of known length, is one at all likely to lead to good results in the field. He believes that as a general principle it is not well to take a very fine sight. If the whole of the barleycorn down to the block be seen over the bar of the back sight, it will be found that variations of light produce almost no effect upon the aim, and that great uniformity of elevation can be maintained without effort, after a little practice. But in such matters no general rule can be laid down, for the only test is success, which different individuals achieve by different methods.

The slow progress of military arms in this country has never hitherto allowed the use of a back sight capable of sliding laterally to make allowance for wind, although such an addition is of undoubted and undeniable assistance to the expert shot, and its use is not at all difficult to teach to the beginner. This is a matter which requires to be tried fairly and without prejudice. Warfare grows more scientific in every decade, and our weapons, both great and small, are now really arms of precision. A recruit of the present day, thanks to the progress of national education since 1870, and the vastly increased supply of literature and instruction of every kind, has more intelligence and general capacity than his predecessors of old times. Wind-gauge sights are not required for sporting rifles, because at the ranges at which they are used it very seldom happens that any considerable allowance has to be made for wind; but with military arms the case is different. The all but universal practice adopted by expert target shots with the military rifle of using the straight edge of the sliding bar to aim over, instead of that side of it in which the V is cut, is due to the fact that wind allowance can be given by this means without loss of elevation, and without varying the point aimed at. The centre of the bar is marked by a line of bright metal; it is usual, however, to blacken the bar, and to put on for firing at any distance a temporary line of white paint, giving what is likely to be the average allowance for the particular conditions at the time. The variations from this average are usually allowed for by aiming a little right or left of the line. By such means very excellent results can be secured. It is perhaps less easy to take an unvarying amount of the barleycorn fore sight over the straight back sight than through the notch of the V, but this is largely a matter of practice, and a little perseverance will soon overcome the difficulty. It is hardly practical that in competitions at the target with a military rifle such a means of making the correct allowance, one quite unsuited to service conditions, should be the only possible way of doing justice to the powers of the rifle. It is of course possible to make the wind allowance by aiming through the V away from the bull's-eye, and, if necessary, away from the target; but the difficulty of maintaining the elevation which this involves has already been alluded to, a difficulty which applies even more in the field than at the target. There are a few ingenious marksmen who succeed in obtaining very first-rate results by using the V sight and tilting the rifle over to the right or left, which causes lateral deviation in the bullet's flight. It is marvellous that a really considerable accuracy can be obtained in this way, and the fact argues exceptional gifts on the part of those who can succeed by this method.

Various forms of sliding and screw wind-gauges for military sights have at different times been invented, but no invention depending upon a screw has yet been accepted in Europe as practical for military work, although there was some question whether a screw wind-gauge fitted to some American rifles should be allowed in the matches with British teams in the years 1882 and 1883. The chief objection to a screw wind-gauge is that it cannot instantaneously be put back to the centre at either long or short ranges when it may become necessary at any time suddenly to direct the fire upon some object quite close by in a different direction. It is necessary in such a case that it should be possible at one movement to return the slide to its central position. Some arrangement to enable this to be done must be an essential part of any military wind-gauge sight.

It is of no use to lay down any special rule as regards the method of bringing the sights on to the target. The only thing that need be said is, that the quicker they are aligned upon it the better. The head being inclined forward in the line of the sights, it soon becomes a mere matter of habit to take up a proper view of the fore sight, seeing the right amount of it accurately centred over the proper part of the back sight. The amount of allowance for wind has previously been decided, but just before the final aim on the bull's-eye is taken and the trigger pressed, a last look is taken at the weather to see that the wind has not changed meanwhile. When this has been done, the sooner the final aim can be got and the rifle fired the better. The writer remembers seeing McVittie shoot off a tie at Wimbledon many years ago. The two competitors were told off to fire at two adjoining targets. While his antagonist was firing his first shot McVittie made two bull's-eyes and an inner, and the prospect of having to do better than this quite demoralised the more deliberate shooter. It is important not to prolong the aim, and it is well, if the aim cannot be quickly got, to bring the rifle down, and rest for a few seconds, before trying again. Nervousness is fatal, but confidence can hardly exist unless the firer is in good practice, and, we may add, in good health. These remarks apply to all the positions in their degree, but perhaps least of all to the back position. In this there is no special demand made upon the muscles; the weight of the rifle does not come upon the arms and hands; and the body is not in a condition of strain. The trigger is pulled to much greater advantage, as the aim can be held, if necessary, for a good many seconds without appreciable variation. Curiously enough, very brilliant shooting has been made in the back position under physical circumstances that would have been fatal in a military competition. There are probably few (if any) men who could, as Major Young once did, make a large score in the match for the Elcho Shield when suffering from an attack of pleurisy; or as he did on another occasion, when almost every shot dislocated his wrist, which had to be put in again. The writer remembers one occasion when an important Match rifle competition at 1,100 yards was won by a marksman who was suffering so badly from neuralgia that he only went to the firing point after much hesitation, and fired shot after shot without the least expectation of making a good score, and feeling utterly indifferent as to the result. Possibly the last point may have had something to do with his success. There is no more fatal condition of mind in which to enter upon an important competition than one of anxiety as to the result. It is well to be reasonably confident that one need not do badly, and it is well to be light-hearted when some miserable shot strays away from the bull's-eye or off the target, in spite of every care. Yet it is equally undesirable to approach a competition in anything of a frivolous spirit, for this usually accompanies a sufficient degree of carelessness to affect the result of the shooting. There can hardly be a finer exercise in the world for the temper than to learn to take the floutings of fortune, the magpie that spoils a string of bull's-eyes, or the miss that comes at a critical moment, without excitement or anger, but only as giving occasion for redoubled care and determination. A match is never lost till it is won; and many an unexpected victory has been gained by a breakdown in the last few shots of those who have so far held the lead. Often has a first prize been lost by the slight demoralisation which has followed in the last two or three shots upon the belief of the leading man that he held the victory for a certainty. Many a time has someone whose first shots were unfortunate attained success in the end, and by continued brilliant shooting made up his lost ground. It is in difficult weather, and at long ranges, that there is most chance for the man who has not begun very well. In very easy weather, when making bull's-eyes is 'like shelling peas,' as it has been well put, there is no room to pick up two or three points dropped by carelessness or misfortune at the beginning of a shoot. When the wind is awkward, so that the allowance has to be judged afresh for every shot, the man who can aim with absolute certainty and steadiness, but who has not a certain quickness of observation, born of sharp wits, and educated by experience, will find himself at a disadvantage, for he has not skill enough to cope with the conditions, and is not really a first-rate shot. There was one well-known long-range shot of the muzzle-loading days, when coaching was allowed in individual competitions, of whom it used to be said that he owed to his wife much of his success, because her observation and judgment of wind were so much better than his! It is extraordinary how sometimes a man who has for years only been a steady shot and a moderately successful competitor, will seem suddenly to rise to a higher level of skill, and will astonish others; and himself too, by his success. This change sometimes follows victory in some important competition, and must then be attributed chiefly to increased confidence. It is probable that the standard of skill, putting aside all question of the accuracy of different arms, is constantly increasing, but it is difficult to believe even in the light of modern doctrines of heredity that human muscles and senses can be much better trained and developed than they are at present.

It is often thought that success in rifle shooting, depending as it does largely on clearness of vision, steadiness of muscles, and delicacy of touch upon the trigger, must be favourably affected by abstinence from alcohol and from smoking. This idea is both true and untrue. The occasional smoke, which hurts nobody, does not, if we may judge by the record of prominent winners at Bisley, make any difference at all to a man's chance of success. The late Sir Henry Halford was hardly ever without a pipe in his mouth, especially when shooting, yet in 1893, at the age of 65, he was eclipsing his own previous performances and those of others, and scoring one success after another with the Match rifle. There are in the front rank of shooters a few who never smoke, and a few who smoke hardly ever, but the majority are moderate smokers. Similarly with alcohol; the Queen's or King's Prize has been won more than once, as in 1901, by a total abstainer, but the abstainer cannot be held to have any appreciable advantage as against an abstemious or a moderate man. There have been distinguished shots from both sides of the Tweed who have enjoyed their glass in its proper place. Of one it used to be said that he could not do himself justice in the last stage of the Queen's Prize unless he had a flask of whiskey under his seat, to be constantly resorted to for encouragement during the progress of the shooting. The matter is largely one of constitution, and still more of habit. The writer has heard it said by Sir Andrew Clark that after an abstinence of two or three months from alcohol, tea, and coffee, a strong cup of tea will upset the nerves, and make the hand shake. Moderation and care, which have the effect of inducing the best physical condition, are undeniably a help to shooting, and more especially in shooting standing, or in any other position in which the rifle depends for support upon the steadiness of strained limbs. But the mental attitude is quite as important. To be suffering from the deprivation of some accustomed and harmless comfort, to be feeling, in fact, any abnormal condition, will distinctly tend against success. To have suddenly ceased smoking the day before, or to shoot a match after breakfast without smoking the habitual pipe, is almost certain to spoil the score, quite as certain, probably, as to be smoking too much. The refreshment contractors at Bisley seem always to find a difficulty in making both ends meet. This is probably due in a great degree to the moderation, verging on abstinence, of the average shooting man, and is most satisfactory as an indication of his intelligence and self-control, even though it make the catering problem a serious one.

The uprightness of the sights at the moment of firing is an important factor in making a correct shot, especially at the longer ranges. It is very easy to tilt the rifle a little to one side or to the other while aiming, and some men, as has been said, fire consistently with the rifle a little tilted. The actual line in which the muzzle is directed at the moment when the shot leaves it, points, of course, higher and higher above the line along which aim is taken through the sights at the target, according as the distance increases. Thus, at 100 yards with the Lee-Metford, the muzzle points 4·4 inches above the spot which the bullet strikes at that distance. At 500 yards with the same rifle the muzzle will point about 13½ feet higher than the point aimed at. With the Martini-Henry it would point 30 feet higher. Now if the ·303 were fired (to take a hypothetical case) at 500 yards with the correct aim, but with the sights not perpendicular, but horizontal, the shot would strike 13½ feet below the point aimed at, and also 13½ feet to the right or left according to whether the rifle had been laid on its right side or on its left. If the sights were tilted to right or left at an angle of 45°, the shot would strike about 8½ feet to the side, and the same distance below the mark. Of course, no one fires with the rifle leaning over anything like so far as this, but it is very easy to lean it over quite enough to throw the shot appreciably wrong. If the inclination be 5°, that is, not quite so far from the perpendicular as the minute hand of a clock points at ~~two~~ minutes before or after the hour, the shot will strike at 500 yards more than 14 inches to one side; it will not, however, strike materially low. With a similar inclination in the case of the Martini-Henry rifle it will strike about 2 feet 7 inches to one side. It is probably not very often that the sight is leaned so far over as 5°, but a tilt of 3° is common enough. The effect of a degree of error does not merely increase in proportion to the distance. For instance at 500 yards, for the same inclination, it is much greater than for 100 yards, because it is proportional to the distance subtended by the angle of elevation used at each range. Thus, with the ·303 rifle at 500 yards the elevation for the distance (31′) subtends 13½ feet; if we consider this as the radius of a circle, 5° measured on its circumference are equivalent to a little over 14 inches. At 1,000 yards the muzzle of the ·303 points 77 feet above the point which the bullet will strike, and that of the Martini-Henry 142 feet, these being the amounts of the fall of these bullets in flying that distance. Consequently the lateral error from a tilt of 5° will be with the ·303 16 feet and with the Martini-Henry 30 feet. At 2,500 yards, with the ·303 the same amount of tilt would give a deviation of no less than 30 yards. It will be observed that the effect of tilting at short distances such as 100 yards is very slight, but it becomes important in making an accurate shot at the longer sporting distances to have the sights properly upright. There is great difficulty about this in some surroundings. In steep ground, where there is no horizontal line to show the eye what is level, it is incredible what mistakes may be made. In standing on a steep slope, and putting up the rifle to aim upon a mark with great care in respect of the uprightness of the sight, it will be found that the spirit-level on the rifle does not at all indicate the sights to be really upright, and that on shifting the rifle until the level is in proper adjustment the general appearance of the sights will be that they are leaning right over to one side. This optical illusion seems to be due to a persistent tendency to cant the sights over so as to bring them more nearly square with the slope on which one is standing than they should be. So strong is the illusion on ground sloping at an angle of 30° or so, that it is almost impossible for the moment not to believe that the spirit-level has got altogether out of gear. The deception to the eye is analogous to that experienced in mountain railways, where trees, and even houses, appear to be out of the perpendicular, because the carriage and the seat occupied by the traveller, which habit leads him to assume to give perpendicular and horizontal lines, are in reality far from doing so. It will be noticed from what has been said that the importance of having the sights upright increases as the range lengthens. Tilting the sights may be avoided in target shooting, and especially where there is a row of targets, by levelling the horizontal part of the sight along the target, or its uprights against a flag-staff or other vertical object, and the careful shot habitually does this. So skilful is it possible to become in putting sights just in or out of level for target purposes, that some shooters, as has been mentioned, manage to make a great part, if not the whole, of their allowance for wind by deliberately leaning the sight over in the direction of the wind to such an extent as will throw the shot the proper degree to one side. The method of giving allowance for wind by tilting the sights is almost too artificial for use in practical shooting and off the range, when there is no distinct guide to the exact perpendicular position of the sights.

The writer considers that it is almost indispensable for telescopic sights for use at long ranges to be fitted with a spirit-level, and that the spirit-level is a very useful adjunct to any kind of rifle. It can be fitted under the protection of the projecting back sight in a very substantial metal setting, as in fig. 68, so that it is very unlikely to be damaged, and if it should be damaged the rifle is, at least, no worse than if it had never been there. Early Swiss target rifles were often fitted with a small plumb-bob attached to the back sight, so that it might be kept upright.

We are reminded, in speaking of the spirit-level, of a curious fallacy that crops up occasionally, and is brought out with the view of preventing the soldier from firing too high. It is to fit a spirit-level longitudinally upon the rifle, and to mark upon it the angles of elevation for various distances, so that when the bubble is brought against one of these the rifle is correctly elevated for the distance in question. This system sounds very simple and effective, although it does not provide satisfactorily for giving a correct direction to the shot; but it has underlying it a gross fallacy, which, obvious as it should be, evidently escapes notice. If the earth consisted of one dead level plain, on which the object aimed at were always to be seen, then such firing by clinometer might be effective; but if the firer is not in the same horizontal plane as the mark, if one is higher than the other, as is almost inevitably the case on the earth as at present constituted, then all that is done is to place the shot very precisely above or below the mark aimed at. Yet a suggestion of this kind has even been thought worthy of mention in the Press in some nodding moment of an editor.

The elevation required to hit an object will evidently be in part dependent not merely upon its distance, but upon its position above or below the shooter. It is quite clear that in firing at an object vertically overhead no elevation at all will be required, whatever the distance of it may be. The bullet travels in a straight line, and the force of gravity, instead of making its path into a curve, acts merely to retard it. The converse would happen in firing vertically downwards towards the centre of the earth. Since in these positions no correction at all needs to be made for curvature of the bullet's path, there is evidently between them a point not far from the horizontal line at which, for the distances which we consider in rifle shooting, the effect of gravity upon the bullet will need the greatest amount of correction. In firing at different angles, as the direction of fire approaches the perpendicular the curve of the bullet's flight will be smaller and smaller.

Supposing the time of flight of the ·303 bullet to be ·516 seconds in 300 yards when fired horizontally, it will, if fired vertically upwards, move in a straight line, but the effect of gravity will be to lengthen its time of flight, so that in the same time it will travel 4·3 feet less than the 300 yards. The additional time required to complete the 300 yards flight will be a very small fraction of a second, since the bullet is still moving at about 1,500 feet per second.

In firing vertically downwards the bullet would be accelerated by about the same amount, and similarly take a slightly shorter time to complete the distance. It is thus evident that in firing upwards, at any angle, a trifle more elevation is required than in firing downwards. The additional elevation required for an increase of 4 feet in the range when firing horizontally at 300 yards is only about seven one-hundredths of a minute of angle (·07′), or about $\frac{1}{4}$ inch of elevation. It is clear, then, that we are not dealing in this respect with large quantities, although at longer ranges they will naturally be much greater in proportion. The example taken is merely a theoretical one, since the ground can hardly slope more than 30° without being absolutely precipitous, and it will rarely happen, unless in firing at or from the top of a cliff, that the angle will vary more than about 25° from the horizontal. If the greatest elevation is required in firing horizontally, as is approximately the case, we should expect, if we neglect the small correction already mentioned for the time of flight, that the angle of elevation upwards or downwards would be approximately, at 15°, $\frac{24}{25}$; at 30°, $\frac{7}{8}$; at 45°, $\frac{7}{10}$; at 60°, $\frac{1}{2}$; and at 75°, $\frac{1}{4}$ of the angle required in firing horizontally.

It is probable that with rook rifles of low velocity vertical shots are often missed because the sighting of the rifle is for horizontal shooting. Where the whole angle of elevation is so small as it is with modern high velocity rifles at sporting distances, the upward or downward angle of fire will require to be very steep if the effect of it upon the sighting is to be more than trifling. In firing at longer ranges, as in war, there is even less probability of its being necessary to shoot at steep angles. When the distances are great, the difficulty of judging them accurately would probably obscure the difference in elevation due to the angle. The typical downhill shot in shooting chamois or other mountain game, in which the sportsman lies at full length and points his rifle straight downwards over the edge of the precipice, while his attendant holds his legs to prevent his slipping right over, is a very exceptional occurrence, and it is hard to give a more definite rule than that rather less elevation should be given than the distance would appear to require.

If a shot be fired vertically upwards there is no tendency for the bullet to turn over on reaching the highest point which it can attain, and it descends base foremost, for the spin is sufficient to maintain it approximately in the same position in which it started. The bullet of the military rifle rises so high that it is only in the very calmest weather that there is any probability of its falling near enough to the firer to be observed. The influence of wind on it is enormous. Not only does it rise to the upper levels of air, where the atmosphere, though somewhat less dense, has much more movement than near the earth, but, in rising or falling, whatever wind there may be inevitably bears upon its side surface, and so exercises the greatest possible amount of influence upon it. It is upon very calm water on a very still day that there is the best chance of observing the descent of a bullet fired upwards. As Mr. Tippins points out, a suggestion which has been more than once made, and which Dr. Conan Doyle brought forward early in 1900, that an effective high-angle fire might be brought to bear upon an entrenched enemy by pointing the rifle upwards, is not really practical, since unless the most perfect conditions of weather prevail it is impossible to tell within 500 yards where a ·303 bullet will fall. The time of the whole flight of this bullet when fired vertically is believed to be about 45 seconds. A bullet fired upwards in vacuo would reach the earth again with the same velocity as that with which it started; in its descent it would gather up again the whole of the speed which it had yielded to the force of gravity in the first instance. In air the case is different. The resistance of the atmosphere retards the bullet in its upward flight, and deprives it of a very large part of the range which it would have in vacuo. Equally, while it is falling from the height which it has attained the air continues to obstruct it, and consequently on returning to the ground it possesses only a very small part of the velocity with which it started. The same is the case even more noticeably with small shot fired upwards from a gun in covert shooting. This in its fall would be an immense source of danger if it were not that the velocity with which it descends is not great enough to do damage.

In such a medium as air, the resistance of which increases enormously with every increase of velocity, all bodies, if free to fall for a long enough distance, will eventually attain what is called their terminal velocity, the speed, that is, at which the accelerating force of gravity is balanced by the increased resistance of the medium. It is quite true that in a vacuum a downy feather and a bullet fall equally fast, but in still air it is very obvious that the feather sinks gently down to the ground without any acceleration after it has once fairly begun to fall. Its terminal velocity is very low. The terminal velocity of the old round musket-ball was less than 300 feet per second, and the blow of a falling bullet, although serious enough, is not by any means so effective as that of one just discharged from a rifle. In firing under ordinary circumstances the bullet remains during its flight closely tangential to the trajectory, and consequently descends point foremost, the angle of descent being always rather steeper than the angle of elevation with which it started. If the elevation be raised more and more from the horizontal there will be some angle, probably between 25° and 40°, up to which the range attained will increase to its maximum. As the elevation is increased beyond this point the range of the bullet will become shorter and shorter, until the rifle is fired perpendicularly, when its range is zero. There will evidently be what may be called a critical angle, at which it will take very little to decide whether the bullet, having reached the top of its flight, will conform to the curve of the trajectory and descend point forward, or whether the curve at the top of the trajectory is too short to develop that tendency. In the latter case the bullet will fall sideways or base downward.

CHAPTER X

ACCURACY OF RIFLES—ESTIMATION OF DISTANCE—RANGE-FINDING INSTRUMENTS—DENSITY OF AIR—TEMPERATURE—ATMOSPHERIC PRESSURE—HEAD WINDS AND CROSS WINDS—VARIABLE CURRENTS—FLAGS AND MIRAGE—WIND AFFECTING ELEVATION—PECULIARITIES OF RANGES—FLAGS—WIND JUDGMENT AND COACHING

Assuming that the rifle is good enough to be able to do all that is required of it in the way of accuracy, two things are essential in shooting with it. The first is that the mechanical part of the alignment of the sight should be quite perfect. The other, the intellectual part, is that proper allowance should have been made for the fall of the bullet at the distance in question for the particular shot, and for any deviation due to wind or other causes. To take the first of these headings. The trained eye, using open sights, and able therefore to make such symmetrical arrangements as they admit of, can attain extraordinary accuracy. The Snider rifle was not to be trusted to make a score at 600 yards or beyond it; at 500 yards any score of 35, the highest possible for seven shots, or within one or two points of it, was very rare, and the same was the case in the shooting at 200 yards. When the Martini-Henry rifle was introduced the scoring rose at once, and strings of seven bull's-eyes at 200 and 500 yards in reasonably easy weather were not infrequent, while it began to be possible to make good scores at 600. It was then discovered that the inaccuracies of the Snider rifle had been much greater than was supposed, and the faults in aiming and making allowance for the weather much less. When the ·303 rifle was introduced it was not anticipated that any very material rise in the score would take place, yet we find that the strings of bull's-eyes, which were occasional, have become so common and so long as to verge upon monotony, and that the Martini-Henry, which in its day was thought to be capable of very accurate shooting at short distances, was in reality not nearly equal to doing justice to the 'holding' of those who used it. This fact alone will show how inadequate the accuracy of the weapons has hitherto been when compared with the skill and trouble devoted to their use. The same has been the case from very early times. Ancient crossbows were in many cases fitted not only with delicate aperture back sights, but with fore sights capable of fine adjustment, a bead, strung upon a wire, supported by two horns of metal, between which the projectile passed, being one of them; yet the accuracy with which the crossbow will shoot is by no means worthy of very delicate sighting. The fact is that there has been at all times a blessed inability on the part of both shooters and spectators to realise that skill is only one of the elements involved, and that with the most accurate arms the ideal shot, which strikes the absolute centre of the mark, demands a large proportion of good luck. The stories of the prowess with the rifle of 'Leather Stocking,' and other heroes of romance, has little more foundation in fact than those of Robin Hood with the longbow, which—alas! for the beliefs of our childhood!—have now finally passed into the domain of fable. Salem Wilder, whose recollections of shooting matches extended back sixty years, in lecturing at Winchester, Massachusetts, in 1892, said that he supposed that most of his hearers had read the wonderful stories which had been printed concerning the shooting of the old Western pioneers like Daniel Boone, of Kentucky, and added, 'Well, doubtless Daniel Boone was a fine marksman, and under the conditions then existing he did remarkable shooting; but there were no rifles then in existence which would stand a ghost of a chance in a test of accuracy, even at 200 yards, if brought into competition with our modern first-class target rifles, while at 500 yards distance a modern target rifle would hit a 10-inch circle oftener than one of the best of the old rifles would hit a 30-inch ring.' The rifle has not yet been made which will 'drive the nail' every shot at a hundred yards, unless it be a nail with an abnormally large head; but one thing is certain, that the more accurate the rifle the better is the work which can be done with it, and that no continuous good work can be done without every care being taken by the shooter. It is of no use, therefore, to expect absolutely perfect results, or, when some extraordinarily good shot is made, to attribute its success entirely to skill.

The second part of good aiming consists in correctly judging and allowing for the conditions of weather and of distance which have to be met, and this is the part which demands something more than mechanical skill of well-drilled muscles and a correct eye, and calls into play all the faculties of quick and accurate observation, judgment, and decision, which are so necessary to success under all other circumstances of life. As regards the adjustment of the sights the first thing is to know the distance accurately, or, if it is not known, to estimate it with some approach to correctness. It is elsewhere shown that owing to the curved form of the trajectory, the bullet will strike above or below the object if the sight be not so placed, and aim so taken, that the line of aim intercepts the path of the bullet at the point which it is desired to hit. In shooting at a target, not only is the distance almost invariably known, but a series of shots are fired, and if the first be too low or too high, the correction for it can be made in the sighting or in the aim. In war it is urgently important that the first shot should strike in the right place, for there may be no opportunity for another; yet the distance is not known unless under quite exceptional circumstances, nor is there in most cases anything to show where the first shot hit, so as to enable the aim to be corrected. The same applies in a large degree to sporting shots, but the estimation of the distance with them is, as a rule, less difficult and less important, because the distances judged are very much shorter than they are in war, and because no attempt is made to shoot at distances at which the trajectory has become very much curved.

Many patterns of range-finding instruments have been invented for military purposes and have obtained a greater or less degree of success. Col. Watkin's Mekometer is an excellent instrument when the proper conditions for its use are present. With it, observations can be made almost instantaneously and very accurately, but it requires two observers, who from the two ends of a cord some 30 yards long stretched between them must be able to see clearly, not only each other, but the distant point, the range of which is to be taken. It is often difficult, in ground which is broken or timbered or cut up by many hedgerows, to fulfil these conditions. Nor is this all. The fact that two observers are required, and that they have to align their instruments with great accuracy upon the same point, leads to difficulties. It requires a very well defined point for observation. It is not enough to say, 'Take that house,' it must be some particular chimney, or particular corner of the building. Very often it is difficult to fix on an object which can be sufficiently well defined and described to give both observers an unmistakable point, and even then mistakes are liable to be made by confusion as to which tree or rock is meant. This class of difficulty applies to all instruments which depend upon two observers. Of other range-finding instruments, similarly depending on a base of some length, but requiring that the same observer should move to different points, and make successive observations, it can only be said that they are far slower in use, and even more dependent upon favourable ground and convenient points of alignment being found. They are, in fact, only capable of being used under very exceptional circumstances, as when preparing a position at leisure for possible attack.

There is another class of range-finding instruments, in which the base is a great deal shorter, and the observation made by a single observer, two images of the object being received at the two ends of the base, and reflected so that they are brought together to the eye. The most successful of these, perhaps, is one which has been adopted in H.M. Navy, the Barr and Stroud range-finder. The base of this is 4 feet 6 inches long, and it has a vertical pivot in the middle so that it may be turned in any direction. It is capable of great accuracy up to long distances, compensation being ingeniously made for such troubles as that caused by the effect of changes of temperature on the metal of the tubes in which the prisms are set. Such instruments depend largely upon telescopic magnification to effect the accurate coincidence necessary for so short a base. The Barr and Stroud instrument has not come into vogue for infantry purposes, and great as are the advantages of using so short a base, no instrument of this kind seems to have been as yet produced which is capable of being used in the field under service conditions. The question is still occupying the attention of scientific men. Any range-finder, if it is to be really useful for military purposes, must be capable of being used under fire, and of rapidly giving accurate readings. The problem, then, of a really serviceable range-finder for use by infantry on service at fighting ranges still awaits a solution. It is really the problem of producing a portable instrument with a self-contained base, capable of very great accuracy in the measurement of minute angles on marks not too well defined, even when handled by a man with no great amount of special training.

In the absence of such an instrument what means have we of determining distance? Very little. The velocity of sound, about 1,100 feet per second, being known, it used to be possible in war to observe the interval between the discharge of a gun and its report, and so to calculate the distance. This method can no longer be used in daylight since the introduction of smokeless powder; the eye, educated by experience, is now the only guide, and it is a guide liable to great deception. Take the Highland gillie, who can judge the distance of a stag or a hind on ground with which he is familiar with an error of perhaps plus or minus 5 to 10 per cent. up to 200 yards, a degree of accuracy which the unskilled man under the same conditions will not be able to approach. Ask him on unfamiliar flat ground to judge the distance of some object of which he does not know the exact size, and increase the distance five or six fold, and it may be imagined what the result will be. The fact is, that the estimation of distance by the eye, while capable of being acquired in a certain degree, must always be incomplete and unsatisfactory. The varying light, the difference between a low sun and a high sun, between the appearance of things towards the sun and away from it, the degree of clearness in an air without mist, the degree of thickness in all stages of mist, fog, or rain, the deceitful appearance of unfamiliar ground and perhaps of water, all seem to make it impossible that a sufficiently accurate estimate of distance for military purposes should be made by the eye alone. Within sporting distances a fair degree of proficiency may be acquired by constant practice on varying ground, the actual distances being carefully paced after being estimated, but it seems impossible to acquire in this way any degree of proficiency in judging distances for infantry fire in war.

The one help which remains is to observe, when practicable, the effect of fire. For artillery fire, at which it is possible to use range-finding instruments, this is still the main check on the correctness of the distance assumed. Colonel Fosbery, V.C., in the Umbeyla Campaign in India, many years ago, used explosive bullets in the Enfield rifle with great success to ascertain distances. The explosion of the shell on striking the ground could be observed, and the elevation thereby corrected, and so given to the other riflemen. Two things have happened since then, besides the abolition of explosive bullets, *i.e.* that the ranges at which fire is effective are much greater, and the size of the bullet, which in favourable ground will make a visible disturbance of the soil where it strikes, is much less. It is even more difficult than formerly to observe the effect of the fire if the movement of a visible enemy do not give some clue to its accuracy or the direction of its inaccuracy. There is probably no better range-finder than a small gun of rather low velocity, firing shells whose explosion on impact can be seen at a long distance ; but this is so cumbrous an instrument, requiring the undivided attention of several men, that it seems an expedient that could not well be arranged to accompany infantry. As hardly needs to be pointed out, the margin of error which can be allowed in ascertaining distances decreases with the increase of distance, and this is why guesswork is so singularly ineffective when we come to the ranges used in war.

Let us assume, then, that the firer knows his distance to a nicety, and knows from careful practice exactly how to align his sights ; he must know, in addition, the peculiarities of his rifle as regards sighting. Eyes and habits of seeing differ, and sights set correctly for one man are not necessarily correct for another. The divisions of the back sight of a rifle are not often correct, even at the shortest ranges, and observation alone can teach the precise adjustments required. Then (we are still considering elevation) come the effects of atmosphere and of weather. The air is sometimes less resistful to the bullet than at others: if the barometer is high, the air is dense, and the bullet takes longer to penetrate a given distance of it, and falls further in the time, hence greater elevation is required.

The density of the air is far more affected by temperature than it is by the variations in height of the atmosphere which the barometer indicates. Sir Henry Halford for a long series of years was constantly shooting at long ranges with the best rifles that could be made, in all weathers both of winter and summer, and making very careful notes of his results. He found in early days that the winter elevations were consistently much higher than the summer ones, and arrived for himself at the true reason, that cold air offers more resistance to the bullet than warm air. He put the change in elevation with the Metford ·461 Match rifle, firing 80 grains of Curtis & Harvey's No. 6 powder, and a bullet of 570 grains, with an initial velocity of 1,300 f.s., and fired at 1,000 yards, at 1′ of angle for every 4½° Fahrenheit of temperature; that is to say, that the variation between a temperature of 30° and one of 80° would be as much as 11′. He states the same fact in another form by saying that the angle which would be correct with the thermometer at 30° for 1,000 yards would be correct when it was at 80° for 1,055 yards. We may picture to ourselves what happens in this way: that the particles of which the atmosphere is composed are closer together in a low temperature than they are in a high one, and therefore the bullet in travelling a given distance will have to push aside more of these particles. The effect of temperature upon the flight of the bullets of modern military rifles, starting at a velocity of 2,000 feet and upwards, is no doubt considerably more in proportion than it was with the Match rifle, although the amount of fall in the whole flight being less, and the angle of elevation for any distance consequently smaller; the total effect will not necessarily be greater. Mr. Tippins, in his book on 'Modern Rifle Shooting,' gives an empirical formula for the effect of temperature changes which is probably about correct. With the ·303 rifle, which almost coincides for the 1,000 yards distance with Sir Henry Halford's reckoning, it is very simple. He says: 'Multiply the number of degrees of change of temperature by the number of hundreds of yards and divide the result by 10.' The result represents in yards the increase of range for which elevation has to be given. Calculated by this method, the effect of a fall of temperature from 80° to 30° would require that the elevation should be raised from 1,000 yards to 1,050 yards. The need for changing the distance allowance in accordance with the temperature is not very material in shooting at close ranges, but it is one of the factors to be taken into account at long ranges, and must not lightly be lost sight of. The modern custom of allowing a sighting shot before the shots to be counted for competition is unsatisfactory in that such considerations as those of temperature, which have to be taken into account if the first shot is to be planted well in the centre of the target, are apt to be lost sight of. Even at long ranges it is very improbable that the first shot will not hit the target somewhere, and the errors of this shot being corrected, the competitor starts fair for the shots which count for the prize list. In match shooting at long ranges it does sometimes, though rarely, happen that a very rapid change of temperature, taking place with or without a shift of wind, is enough to cause a general round or two of misses, which the really observant competitor may be lucky enough to escape.

If the barometer is low, the density of the air is less, and the elevation necessary is accordingly diminished. Yet the variation due to this cause is hardly noticeable even at long ranges under ordinary circumstances, the fluctuations of the barometer not being very extensive at any given level. It is probably not very far from the truth to say that an inch of rise or fall in the barometer has the same effect as a corresponding change of 15° in temperature. Thus the state of the barometer may tend either to counteract or to increase the variation from the normal required by the temperature on any particular day. The effect of the density of the air as shown by the barometer is not so great that it need be separately taken into account in shooting under ordinary conditions, especially at short ranges. It has, however, considerable effect under circumstances, not of variation of the weather at sea-level, but of change of station of the shooter. At high mountain elevations, such as sportsmen attain in the Rocky Mountains in the West or on the plateaux and mountain ranges of Asia, the reduced density of the air flattens the trajectory quite appreciably, and is very well worth noticing. A height of 5,000 feet means a reduction in the height of the barometer from 30 inches to a little under 25 inches, and this would correspond to a temperature difference of about 75°. The practical result is this, that in going to very high altitudes it would be worth while to check the sighting of the rifle carefully rather than to attempt for sporting ranges to make a correction by calculation of the density of the air.

Changes of elevation to meet variations of density in the air are as nothing compared to those due to the effect of wind. It took several hundred years of knowledge of firearms before the full effect of the resistance of the air to the bullet was appreciated. We are wiser now, and can appeal even to our own experience. The high speeds of locomotion of the present day, whether on board ship, on bicycles, or in the train, have taught everyone what a material factor in resistance and in pace the wind can be. Winds blowing from 50 to 100 miles per hour are classed as gales or hurricanes, and can do an immense amount of damage. The speed of the Lee-Metford bullet starting upon its flight is fully 1,300 miles per hour, and any increase or decrease of the resistance of the air is accordingly very noticeable as affecting its speed. The effect of a front or rear wind upon the bullet may be understood by considering how far the wind travels with or against it while the bullet is in the air. The time of flight of the ·303 bullet for 1,000 yards being 2·3 seconds, supposing the wind to be meeting it at the rate of 30 miles an hour, the wind will in 2·3 seconds have travelled 105 feet, or 35 yards, and accordingly, instead of passing through 1,000 yards of air during its flight, the bullet passes through 1,035 yards. Nor is this all. The resistance varies, not in proportion merely to the quantity of air, but in a very much higher ratio, due to the speed of the air and of the bullet. The rule given by Mr. Tippins for the difference in elevation due to a direct front or rear wind is as follows: 'Multiply the velocity of wind in miles per hour by the number of hundred yards in the range, and divide the result by 4. This will give the increase or decrease of the range for which elevation is to be given in yards.'

It will be seen that when strong winds are in question, and especially when they are combined with differences of temperature, the variation in allowance from one day to another may be very considerable indeed. It is simple enough to allow for wind when it is only blowing straight up or down the range, but wind has a very perverse way of blowing at one time or another from all points of the compass, and also of constantly shifting to some extent its direction, so that when it is blowing as straight as possible up the range, it is almost certain to swing a little to one side or the other with quick changes, varying sufficiently to make the shooting difficult at long range. According to the direction of the wind, as well as its strength, so will the allowance need varying. It is, of course, most when the wind is straight across the range or the direction in which the shot is fired, not only because it is then most effective to carry the bullet out of its straight course, but because the surface of the bullet exposed to its influence is much larger than when the bullet is meeting the wind or flying from it. Mr. Tippins, as the result of much experiment, gives a table of wind allowances which must be very near the mark for all practical purposes. The direction of the wind is in ordinary rifleman's parlance described by the figures on a clock-face. It is assumed that the firing point is in the centre, and that the target represents 12 o'clock. A wind blowing from the target to the firing point is called a 12 o'clock wind; winds from the right and left 3 and 9 o'clock winds, and so on. Mr. Tippins considers that with the wind at 2, 4, 8, or 10 o'clock, the amount of allowance required will be two-thirds of what it is with a wind of the same strength blowing from 9 o'clock or 3 o'clock; and that if its direction is from 1, 5, 7, or 11 o'clock, one third of the same allowance will be required. By giving for each 100 yards up to 1,000 yards the allowance required for six different degrees of strength of wind (gentle, moderate, fresh, strong, very strong, gale), he forms a very useful table, which we do not presume to copy, for practical shooting with the ·303 rifle. If a spherical bullet were used, the effect of the wind upon it would no doubt be strictly proportionate to the angle at which the wind meets it, because the form of the bullet acted on by the wind does not vary, whereas with a long bullet the surface exposed, for instance, to a side wind is quite different from that exposed to a wind from 11 or 7 o'clock.

For bullets of a larger bore the proportions of allowance for winds of different directions approximate more nearly to those for the spherical ball, than is the case with more modern rifles. Sir Henry Halford gives, in his little book, a table of wind-allowances for the old Match rifle up to 1,000 yards. With this rifle Mr. Metford considered that at 800 yards, if the wind was square across the range, 1′ or 8 inches of allowance had to be made for every mile per hour of the wind speed; thus, a wind moving at 20 miles per hour would require 20′ of allowance. At shorter ranges somewhat less in proportion is required, at longer ranges something more, since the velocity of the bullet is variable, and the wind has a longer time in proportion to act upon it at long ranges than at short. Judging the amount of allowance to be made for wind is largely a matter of practice and of habit. There are a very few people to whom it comes after some experience almost instinctively, and who do not appear to require any large amount of practice to maintain their skill. For the first shot it is well to consider what the strength of the wind is, and what the allowance should be, supposing it to be blowing straight across the range. By taking a proper proportion in accordance with the angle at which the shot is to be fired, the amount of allowance to be made can then be closely arrived at, and at the same time the variation from the normal elevation due to the direction of the wind allowed for. When the target has been found, there comes in the additional difficulty of the variation of the wind from shot to shot. There are places and there are ranges where this commonly amounts to very little; by the seaside, where the wind is usually strong, a long series of shots may sometimes be fired with a large allowance for a stiff breeze blowing across the range with almost no alteration, the shots continuing to group themselves well into the centre of the target. Paradoxical as it sounds to say so, there is no weather in which the shooting is so easy as when it tends to be foggy and thick, for at such times the great cause of wind currents, the heat of the sun, is absent. The ordinary course of a typical English summer day is interesting to watch from this point of view. Just before dawn all will be still; not a leaf stirs upon the trees, not a blade of grass sheds its dew-drops; there is a gentle tendency to haze, smoke rises quite perpendicularly, and the atmosphere seems to be absolutely placid and calm. But as soon as the sun has risen well above the horizon trifling currents are set up, and by the time that it is well up in the sky, if the day be not cloudy, the eddies will have grown and grown into a decided movement of the air. It may be that a brisk breeze will arise, or it may be that constant restless eddyings and temporary shifting currents only will prevail, but this is far rarer. Then, as the sun droops in the heavens the breeze dies away slowly, the eddyings diminish, the flags to which the marksman looks to guide him in estimating the wind's strength and direction, droop little by little, till they hang motionless against their poles. Then, as has often been seen at Wimbledon and Bisley, comes the lucky hour or half-hour, during which a long string of bull's-eyes can be made without difficulty, and some score within a point or two of the highest possible, made at an earlier hour of the day, with much strenuous effort and good judgment, and, no doubt, a little good luck, is dethroned from its pride of place. Of course it will often happen that many consecutive days are accompanied from start to finish by blustering winds, and that the calm time never comes. At Bisley, for instance, in 1894, for several days in succession the wind blew so strongly across the range that at 900 yards the average allowance for it was 22 feet, just the distance from the bull's-eye of one target to the bull's-eye of its neighbour. This is, of course, exceptional, but it may serve to give some idea of the amount of allowance necessary at times. As with the bicycle, so with the bullet; a wind blowing fairly across the course becomes something of a headwind owing to the speed of the moving body, and acts upon it more effectually than if it had no progressive motion. Owing to the resistance created by its own speed, the bullet is far more affected by a side wind during a given time of flight than it would be if merely allowed to fall for the same period in air similarly moving.

In spite of their greater velocity the wind-allowance with the ·303 or the ·256 rifle is very considerably more than it used to be with the Match rifle of ·461 calibre, with its heavy bullet, since the lighter bullet is very much more affected by a side wind. The allowance with the ·303 rifle may be taken to be about 30 per cent. more than it was under the same conditions with the old rifle, and that with the ·256 rifle decidedly more again. It must not be supposed that the strongest winds are always the most fatal to scoring: the light, eddying breeze that changes in a moment and swings round with some invisible current in the path of the bullet instantaneously, as it seems, between the moment of aiming and the moment when the shot is in the air, is, perhaps, the most difficult and baffling of all. When, as may sometimes be seen, the flags at the firing-point show a current from the right rear, those at the target another from the right front, and perhaps those half-way down the range one from the left, it becomes almost as much a matter of guesswork as of judgment to estimate the combined effect of all these upon the bullet. Flags, too, in such winds are often notorious liars; they are usually higher in the air than the trajectory of the bullet, and the currents at different elevations may be influenced by some obstacle which diverts the air at a particular place. When the sun is shining, as it usually is when the wind is particularly tricky, it is often possible to get some help by watching the movement of the mirage or boil of the heated air as seen against the target. Curiously enough, this is a much truer guide than the flags, and its apparent movement seems fairly well to sum up the average effect of the different currents, but it has to be watched closely, for the slight drift one way or the other which can be observed will sometimes instantaneously disappear, or change to the opposite direction. In tricky weather there is scope for a good deal of luck as well as of skill in making a good score, for the change may come just after the last look at the wind, and before the trigger is pulled, or it may happen not to do so. In long-range competitions a man may often be heard to exclaim at such times, after firing his shot, that the wind had changed while he was aiming, and too often this is confirmed by the shot being marked away from the bull's-eye. The advantage of aiming and firing quickly under such conditions is obvious, and the slow, poking shot will often waste his own and his neighbour's time, and secure only a worse result after all than if he had shown more promptitude.

It is a good rule, when in great doubt about changing the allowance after a successful shot, not to do so. Sometimes at long ranges the wind will apparently alter a good deal, and the marksman will make what he thinks to be a corresponding allowance, only to find towards the end of his shooting, that if he had consistently fired with the average allowance, and without altering it, his score would have been better than it was. It happens often enough that one or two shots, which are really a little wide of the proper group of the rifle to one side or the other, will, being reckoned as straight shots, disturb the shooter's judgment of the wind in his subsequent shots enough to spoil his score. Sometimes, of two men shooting at the same target, one will be found to have fired all through with very little change of allowance, while the other may have made many alterations, and yet both will have made good scores. This is an illustration of how much may be due to the element of luck which comes in on certain days when the wind changes a good deal, since for one man it may happen to return to its average strength at the moment when he happens to be firing, for a majority of his shots, while for another it may not. Judging the wind can never be reduced to an exact science, since often enough a small local gust at the firing point deceives the shooter into thinking it a real change, or some increase takes place further down the range which is not obvious at the firing point.

In weather in which the changes of wind are very considerable, young shots are apt to forget that every change of direction of the wind is apt to require some change of elevation. For instance, a wind which shifts in direction from 3 to 1 o'clock, or from 6 to 4 o'clock, as sometimes may happen, will require a distinct rise in elevation, since it adds to the time of flight, but the contrary is the case if the winds shift from 1 to 3 o'clock, or from 4 to 6 o'clock. The writer remembers one occasion, when, in a long-range competition, with a fairly light wind, almost everybody began to miss before they had observed that the wind had shifted from 2 to 12 o'clock, and required an additional elevation of about 4′.

The amount of the allowance to be made for the wind is, of course, most easily learnt and explained, and put into practice, in target shooting, but it has also its practical application in the field. The experienced man knows at least this much, which to the inexperienced man is incredible, that if there is anything of a cross wind, it is quite certain you cannot hit a small object by aiming at it. In deer-stalking, or for a long shot at antelope, it is very important to know how much allowance is likely to be required. An illustration of this may be given. It was on a very windy day in Scotland, and a stag had been shot at lying down in high ground. The wind made it difficult to hold the rifle steady. He was badly wounded, and looked like falling, but managed to carry on, being encouraged by a smaller stag, which would not leave him. The ground was bare, and he went slowly for about a mile, stopping occasionally; he was led on, and there was no cover in which he could conceal himself. It was getting late in the day, and though it was evident that he could not go much further, there was a chance of losing him. He was followed, of course, and one or two attempts made to intercept his retreat, but in vain. At last the two stags stood for a few moments in a shallow bottom, and their pursuers had time to come within sight of them, and near enough for a long shot round a shoulder of a knoll. Unluckily, before the shot could be fired the animals moved on, crossed a little burn, and began to ascend the slope on the other side. 'It is no use now,' said Angus, for if an ineffectual shot were fired, there was every probability that they would increase their pace, and go quite out of reach. But after going some 50 yards over the burn, the wounded stag stood and turned broadside. It might be possible to kill him. The Lyman sight had been screwed up for a long shot as he had moved away, but a strong wind was blowing exactly across the line of fire. 'I think I'll try him.' A quick but careful aim was taken, and the trigger pulled; he staggered forward a few yards, and fell, never to rise again. The distance was carefully paced afterwards, and found to be not less than 240 yards. Now the point of the story is this, that the bullet struck him well forward in the shoulder, and that aim was taken on his haunch, close to the tail, as he stood offering a fair broadside. Probably no one without a good deal of experience of the effect of wind on a bullet would have made so bold an allowance, firing when there was not a second to spare, and no time to enter into elaborate calculations.

It must not be supposed that it is always a straightforward matter to judge the wind. Wind currents are very curious things, as may be noticed in mist, or when snow is falling. Just as the stream of a river is in any straight part of its course fastest in the middle and at the top, and slowest at the sides and at the bottom, so the movement of the air is greatest where it is not impeded by the earth drag which interferes with its motion. Sometimes, when there is only a brisk breeze near the ground, the shadows of high clouds show that aloft the wind is travelling at 60 miles an hour. With the free movement of the air every blade of grass, every ear of corn interferes; still more does every bush and tree; and, in a yet larger degree, every elevation or depression of the ground. The formation of snow-drifts shows this well; large eddies are formed where the circumstances are favourable, as where the ground is steep, and the wind always tends to follow a valley or depression in the ground, much as it blows either up or down the line of a street. The man who is accustomed to stalk game, whether rabbits or stags, gets to know something of the variableness of currents. If he takes to target shooting, and fires on different ranges, where the configuration of the ground varies, he very quickly finds that they have their peculiarities accordingly. Oddly enough, a range apparently sheltered is often actually the most difficult, because a straightforward wind, however strong, can be judged, but when eddies and cross currents are set up, the peculiarities of the range, and the amount of allowance to be made when the wind is in any particular direction, are only to be learnt from experience. There are said to be ranges, sheltered by steep ground, on which, when a strong breeze is blowing across them from one side, the allowance really needs to be made on the other, since the air through which the bullet moves is not the direct current, but an eddy moving in the opposite direction. A range with a deep dip between the firing point and the targets, which perhaps is not at all obvious from the firing point, will require more allowance than if the ground were flat all the way, because in any cross wind the current will be much stronger where the bullet crosses the dip. For such peculiarities of ranges it is impossible to lay down any but very general rules, and the principal thing to be depended upon is the observation and judgment of the shooter himself.

On most ranges there is something in the way of flags to assist the judgment as to the behaviour of the wind. But here, again, special experience may be necessary. The flags used at Bisley are long pointed pennants, 21 feet in length, and these show a light breeze to great perfection, since their delicate points are lifted almost by a slight drift. As the wind increases the flag is more and more completely raised until it is extended to the full. The heavier the material of which the flag is composed, the stiffer will be the breeze required to extend it fully, and thus some difference between the size or weight of the flags of an unknown range and those of the range to which one is accustomed may prove quite misleading if the deductions are not made very cautiously. One not uncommon snare in a light wind is brought about by the flag becoming twisted round its pole, and looking as if it were hanging in a dead calm, when really there would be wind enough to raise it if it were free. The flags on the range at Bisley are not of very heavy material, and with a wind of more than about 12 to 15 miles an hour they begin to fail to respond to its slight variations. When once the breeze has reached the strength at which the flag is blown out rather stiffly, there is only one further indication of increased strength: the point or outer edge of the flag begins every now and then to kick upwards into the air, as if in a violent effort to free itself. Usually when the limit has been reached to which flags will show the wind, there is nothing much to rely on, beyond a feeling that the wind is more or less strong, and anything that general observation may point out as giving some indication. The writer remembers an experienced shot who noticed on one occasion that when the wind increased beyond a certain strength the halyards of a neighbouring flag began to drum against the pole, and kept his ears open for this indication. We no longer have one guide that used to furnish most useful information, the drifting in the wind of the smoke from the rifles; but where several targets are in use at the same time, there remains an excellent indication that is always worth watching for, a general tendency of the shots fired by others to go wide to one side or the other. It is important, however, to be very cautious in drawing deductions from the shots of other people. Sometimes, when a man gets a wide shot, and it is naturally assumed that the wind has changed, what has really happened is that he has imagined a change and allowed for it; sometimes a wild shot caused by an abnormally bad let-off will hopelessly mislead the next firer. It is important, then, to trust to one's own judgment very largely, and only to assist it by the observation of what happens to others. The wind may become stronger at one moment, and then return to its normal velocity; a light wind may similarly change in direction, and return more or less quickly to a normal direction. In shooting in matches, or for prizes, it is bad form, and unfair to others, to do what sometimes has been done: when the wind has changed from its normal, to refrain from firing with the view of waiting and waiting until it has come back again. Sir Henry Halford says on this point: 'I do not think it well to alter the sight for small changes, but this must be done when evident changes are taking place; it is generally best to wait a few seconds till the flags show that the wind is about as it was when the last shot was fired. This waiting, however, must not be carried too far; I have often seen it done in match shooting to the annoyance of all the other competitors. When this is done habitually it shows selfishness of character, and is not good style.'

The ranges at Bisley and elsewhere, where competitions are habitually held, are very systematically flagged, but on many country ranges flags are scarce. The writer has often shot upon a long range in the country where the movement of the wind in the boughs of a large tree nearly in the line of the range was the chief guide as to changes in the strength or direction of the wind. Useful indications are often given by the movement of long grass, and at the right time of year corn-fields show excellently the wind currents that are passing. As a general rule, it is wisest not to be too ready to alter the wind allowance merely upon the suspicion of a change of wind; on most days, and especially when there is an appreciable amount of it, the changes will be gradual rather than sudden, and it is wiser to 'hedge,' and not make quite the full apparent alteration, than to make large changes. A puff may come sometimes, but it will often die down as quickly as it rose, and if too bold a change has been made for it, the result may be disastrous.

In the very difficult weather caused by the light, shifting airs of which we have spoken, weather that is far more difficult at long ranges than at short, it will occasionally happen that in a series of ten or fifteen shots the wind allowance has to be judged afresh for every single shot, because the conditions are so unstable that they do not remain the same even for the interval of two or three minutes between the shots of each competitor. The constant watchfulness, which is at all times necessary to obtain good results at the target, is especially indispensable at such times, and, it may be added, involves appreciable wear and tear of the nervous system. In exceptionally tricky weather there will sometimes be such rapid variations of the wind as to make it necessary to change the allowance four or five, or even six times before the shot can be got off. The eyes have to be kept on the watch for any signs of change until the moment of the final aim and of the trigger being pressed.

In properly organised team shooting much of the exertion to the firer of watching the wind while firing is avoided. The best results in the match for the Elcho Shield of late years have been attained by the good organisation and good coaching which the teams have had at command. There is many a man who can be trusted to fire every shot of a long series with perfectly correct aim, but is not himself a first-rate judge of wind. With a really good judge of wind (and there are not a great many of them) behind him to inspire confidence, to watch constantly every indication of the weather, and to give decided orders as to the changes in allowance which are to be made, such a man, loyally following the instructions given, and concentrating himself merely on firing with a perfect aim, will have an even better chance of making a big score than the man who is coaching him would were he himself firing without assistance. The qualities required in a coach cannot be better illustrated than by the following example. It was in the Elcho Shield match. The man firing, an exceptionally fine individual shot, was in a very nervous state, and kept hesitating to fire. The coach, who had already told him what he considered the proper allowance to be, bade him fire his shot, as he was sure that it would be a bull's-eye. But he still hesitated, and presently said, 'Will you swear that it will be a bull's-eye?' 'Yes,' said his coach with great presence of mind, 'I swear it will be a bull's-eye.' The doubtful marksman under this assurance fired his shot, and a bull's-eye it was. So firm and so confident does a coach require to be, or at all events to seem. Even the most accomplished judge of wind will gain something by having a trustworthy man behind him who has nothing to do but to watch for changes, and to stop him from pulling the trigger as one comes on. The biggest scores on record at long ranges have been made under such conditions. Major Gibbs's often quoted shooting at Wistow, in 1886 (see p. 490), when he made at 1,000 yards 48 bull's-eyes out of 50 shots, ending with a string of 37 consecutive bull's-eyes, was made in quite steady and rather foggy weather, his judgment being assisted by all Sir Henry Halford's experience and watchfulness. Major Lamb's record for Wimbledon and Bisley of 220 points out of a possible 225 in shooting for the Army against the Volunteers, in 1892, under Elcho Shield conditions (15 shots at 800, 900, and 1,000 yards), and his big score of 219, made in 1893, in the Elcho Shield match, were both made under the careful coaching of Colonel Hopton, then Captain Dutton Hunt. The wind at Creedmoor and in the United States generally, as in India, is habitually so much steadier than here, that it was possible for the American teams to work on the following principle. The two or three men firing at the same target, when they had begun, would go on firing without any question of a change until one of them had a shot which was out of the bull's-eye to one side; then, after consultation, the next one would probably alter his allowance accordingly, and the shooting would proceed until another change showed itself in the same way. At Bisley, on the other hand, and the same was the case at Wimbledon, the attention of the coach is constantly occupied in watching and judging the wind, and it is only under exceptional conditions that even a short series of shots is fired without some change of allowance.

What has been already said about sighting shots, and their disadvantage in depriving the judgment on which the first shot is fired of its fair value, applies almost more to team shooting. In the Elcho Shield match no sighting shots are allowed; the allowance for wind and elevation to be made for the first shot of each team and of each man is accordingly the subject of very careful consideration by the shooter himself and also by the coaches, for the loss of two or three points on the first shot is a serious matter.

CHAPTER XI

ANGLES OF ELEVATION — TABLES FOR ·303 AND OTHER RIFLES — SHAPE OF TRAJECTORY—ANGLE OF DESCENT—TRAJECTORY DIAGRAMS AND TABLES — SHOOTING AT EXTREME RANGES — SHAPE OF BULLET — TUBULAR BULLETS

The simplest method of sighting a rifle is by ascertaining from experiment what height of back sight is necessary at any particular distance, and this can be measured by any convenient means. The only method by which a proper comparison can be made between the elevation required by different rifles is to measure the elevation on the back sight in degrees and minutes of a circle which has the fore sight for its centre. In this way the precise angle of inclination of the barrel above the mark is accurately measured and expressed in the same terms, whether the barrel be short or long, and whether the sights be near together or far apart. We have described elsewhere the means by which the zero or basis of the scale of elevation is found. It is evident, since the bullet in its flight falls with increasing rapidity, that the rise of elevation in the second hundred yards will be greater than in the first hundred, and that in the third hundred greater than in the second hundred, and so on, the curve described by the bullet growing gradually steeper. If the angles for three or more distances are correctly known, it is possible to construct tentatively a table of angles which shall give the elevation for the intermediate distances. In dealing with such matters it is necessary to check by experiment very carefully the series of angles arrived at. We give here a complete table, which appears also in the official Text Book for Small Arms, 1894, and for which Sir Henry Halford and Mr. Metford are responsible, giving the angles of elevation for the ·303 rifle up to 2,500 yards. It is certainly correct, so far as it

ANGLES OF ELEVATION FOR ·303 LEE-METFORD RIFLE [1]

Velocity, 2,037 *f.s.* *Service Load*

Range	Angle	1st Difference	2nd Difference	3rd Difference
000	0·0000000′	4·4039233′		
100	4·4039233′	5·2524333′	0·84851′	0·049′
200	9·6563566′	6·1499433′	0·89751′	0·049′
300	15·8062999′	7·0964533′	0·94651′	0·049′
400	22·9027532′	8·0919633′	0·99551′	0·049′
500	30·9947165′	9·1364733′	1·04451′	0·049′
600	40·1311898′	10·2299833′	1·09351′	0·049′
700	50·3611731′	11·3724933′	1·14251′	0·049′
800	1° 1·7336664′	12·5640033′	1·19151′	0·049′
900	1° 14·2976697′	13·8045133′	1·24051′	0·049′
1,000	1° 28·1021830′	15·0940233′	1·28951′	0·049′
1,100	1° 43·1962063′	16·4325333′	1·33851′	0·049′
1,200	1° 59·6287396′	17·8200433′	1·38751′	0·049′
1,300	2° 17·4487829′	19·2565533′	1·43651′	0·049′
1,400	2° 36·7053362′	20·7420633′	1·48551′	0·049′
1,500	2° 57·4473995′	22·2765733′	1·53451′	0·049′
1,600	3° 19·7239728′	23·8600833′	1·58351′	0·049′
1,700	3° 43·5840561′	25·4925933′	1·63251′	0·049′
1,800	4° 9·0766494′	27·1741033′	1·68151′	0·049′
1,900	4° 36·2507527′	28·9046133′	1·73051′	0·049′
2,000	5° 5·1553660′	30·6841233′	1·77951′	0·049′
2,100	5° 35·8394893′	32·5126333′	1·82851′	0·049′
2,200	6° 8·3521226′	34·3901433′	1·87751′	0·049′
2,300	6° 42·7422659′	36·3166533′	1·92651′	0·049′
2,400	7° 19·0589192′	38·2921633′	1·97551′	
2,500	7° 57·3510825′			

goes, for it was checked by Mr. Metford up to fully that distance. Yet, such a table is never to be depended upon at distances beyond those at which it has been actually tested. It will be seen that the third difference is a constant quantity, and that the other differences and the angles are obtained merely by addition. A similar table can be constructed for any rifle with any load, but it will usually require to deal with many figures in the decimal columns. A word of warning here as to this is advisable. Although the steps of increase at each stage are in perfectly regular progression, yet if, to

[1] This table depends upon a formula given to Mr. Metford by Mr. William Froude, C.E., which is fully explained in the Text Book for Small Arms, 1894. It is as follows:—Angle of elevation in minutes

$$= nA + n\frac{n-1}{2}B + n\frac{n-1}{2}\cdot\frac{n-2}{3}C + n\frac{n-1}{2}\cdot\frac{n-2}{3}\cdot\frac{n-3}{4}D\ldots$$

where n = the range in yards; A, the angular value of the fall for 1 yard in vacuo; B, C, D, values for air resistance, which have to be determined for each particular bullet and charge.

save space, they are only given to one or two places of decimals, and if then the differences be taken out from the figures as they stand, apparent discrepancies will arise, by dwelling on which the table can be made to appear inaccurate, although it is really so only in the omission of detail for the sake of convenience. The path of the projectile as given in the table of angles is one to which no individual shot can be expected absolutely to conform, for some deviation from the normal of every shot of a group fired is quite noticeable, but the trajectory table will give the central line round which the group of shots will form itself at each distance.

Such tables are not capable of perfectly rigid application. They are arranged to be correct for a normal temperature of 60° and a barometric pressure of 30 inches, and as is mentioned elsewhere, the variation of these conditions affects the flight of the bullet considerably. They represent, therefore, standard curves which any variation of temperature or pressure will affect proportionately in all of their parts. Wind pressure from the front or rear has a similar effect. The writer prefers building up tables of angles which accord with the experience of a good many hundred shots to any attempt to lay down what the path of the bullet should be from considerations of the effect of gravity, and of what in theory the loss of velocity from the resistance of the air should be at each stage. He has known calculations based upon Bashforth's admirable experiments to go entirely wrong from want of appreciation of the differences introduced by the use of leaden instead of iron shot, and by alteration in the shape of the head. In trajectory work, as in more abstruse matters, calculation may be misleading unless it goes hand in hand at every step with experiment.

Besides a complete table of the angles of elevation for the ·303 rifle for a velocity of 2,037 f.s., and the normal Metford bullet of 215 grains, there has been added an elevation table for the Martini-Henry rifle up to 1,200 yards, for a velocity of 1,315 f.s., and a bullet of 480 grains; and one for the old Metford Match rifle of ·461 bore up to the same distance for a velocity of 1,300 f.s., and a heavier bullet of 570 grains, which, owing to the shape of its head, as well as its weight, has a lower trajectory than that of the Martini-Henry. The table for the ·402 experimental rifle is carried to 2,000 yards, its velocity being 1,570 f.s., with a bullet of 384 grains. These tables of angles correspond with the trajectory curves shown in the diagrams. Similarly with the ·256 Mannlicher, for which a table of angles up to 1,100 yards is given.

Those who have tried shooting at unknown distances will most easily understand the advantages gained by high velocities combined with flat trajectories. The chief difficulty in the field, a difficulty which begins almost where the whole instruction in the art of aiming and firing correctly at the rifle range ends, is that of ascertaining the distance of the mark. As the firer is further from the mark, not only is it more difficult for him to estimate the distance accurately, but the flight of the bullet demands that it should be even more nearly known than at closer distances. For instance, while an exposed man standing would be hit at any distance up to 565 yards by the bullet from a ·303 rifle sighted for that distance, and aimed at his feet, the flight of the bullet when fired with suitable sighting at a man 1,000 yards away will only jeopardise him if the distance be judged correctly to within less than 25 yards one way or the other, because the angle at which the bullet falls is so much steeper at further than at nearer distances. At 1,000 yards with the Lee-Metford it is about 2° 25′. At 2,000 yards the bullet is falling at an angle of about 10°, and the danger zone for the man is only about 12 yards.

It is, of course, four times as hard to judge the distance at 2,000 yards to within 12 yards as it is to judge it at 1,000 yards within 25 yards, but much greater errors in estimation of distances than that of 25 yards at 1,000 are frequently made. With the Snider rifle, independently of the inaccuracy of its shooting, a far more exact estimation of distance was required, as the more rounded character of its trajectory at once shows. It is, perhaps, hardly necessary to enlarge upon this subject, since it is one the comprehension of which goes with the most rudimentary knowledge of the flight of a bullet. Whereas in early times the path of a projectile was imagined

ANGLES OF ELEVATION

MARTINI-HENRY RIFLE		METFORD MATCH RIFLE		·402 EXPERIMENTAL RIFLE		·256 MANNLICHER	
Velocity : 1,315 f.s. Charge : 85 grains R F.G. Bullet, 480 grains		Velocity : 1,300 f.s. Charge : 80 grains Curtis & Harvey's No. 6 powder. Bullet, 570 grains		Velocity : 1,570 f.s. Charge : 85 grains Curtis & Harvey's No. 6 powder. Bullet, 384 grains		Velocity : 2,350 f.s. Charge : Smokeless powder, about 37 grains. Bullet steel-sheathed, weight 156 grains	
Range	Angle	Range	Angle	Range	Angle	Range	Angle
100	11·3′	100	10·25′	100	7·30′	100	3·3′
200	23·8′	200	21·40′	200	15·80′	200	7·3′
300	37·5′	300	33·45′	300	25·53′	300	12·1′
400	52·4′	400	46·40′	400	36·48′	400	17·7′
500	1° 8·5′	500	1° 0·25′	500	48·68′	500	24·2′
600	1° 25·8′	600	1° 15·00′	600	1° 2·12′	600	31·7′
700	1° 44·3′	700	1° 30·65′	700	1° 16·83′	700	40·3′
800	2° 4·0′	800	1° 47·20′	800	1° 32·80′	800	49·9′
900	2° 24·9′	900	2° 4·65′	900	1° 50·06′	900	1° 0·8′
1,000	2° 47·0′	1,000	2° 23·00′	1,000	2° 8·60′	1,000	1° 12·8′
1,100	3° 10·3′	1,100	2° 42·25′	1,100	2° 28·45′	1,100	1° 26·2′
1,200	3° 34·8′	1,200	3° 2·40′	1,200	2° 49·60′		
				1,300	3° 12·07′		
				1,400	3° 35·88′		
				1,500	4° 1·02′		
				1,600	4° 27·52′		
				1,700	4° 55·37′		
				1,800	5° 24·59′		
				1,900	5° 55·20′		
				2,000	6° 27·19′		

to be in a straight line, or practically so, for a considerable distance, and then, when the speed failed, to curve quite suddenly until the projectile fell perpendicularly, it has been recognised fully since the experiments of Robins in 1740, that this is not the case, but that the effect, firstly, of gravity, and then of the resistance of the air, is to make the path of any projectile into a curve. This curve, while it is very gradual in the beginning of the flight, becomes steeper and steeper during its whole length, for the double reason that the projectile is retarded by the resistance of the air, while its downward motion, due to gravitation, is constantly increasing.

The angle of descent of a bullet at different distances can very easily be found if a complete table of angles of elevation for the particular rifle is available. The method was devised by Sir Henry Halford, and is thus stated in the official Text Book for Small Arms, 1894:—

'First find the increase of angle required to cover the last yard of the distance at which it is desired to find the angle of descent.

'To do this, add the increase of angle for the last 100 yards of this distance (α) to the increase of angle required for the 100 yards beyond it, (β) and divide the sum by 200. This will give the mean increase of angle for each yard of these 200 yards.

'This mean increase, though accurate enough for practical purposes, may be corrected for the precise yard in question by subtracting $\frac{\alpha+\beta}{100}$. The formula will then be $N\frac{\alpha+\beta}{200}-\frac{\alpha+\beta}{100}$ = angle of descent in minutes.

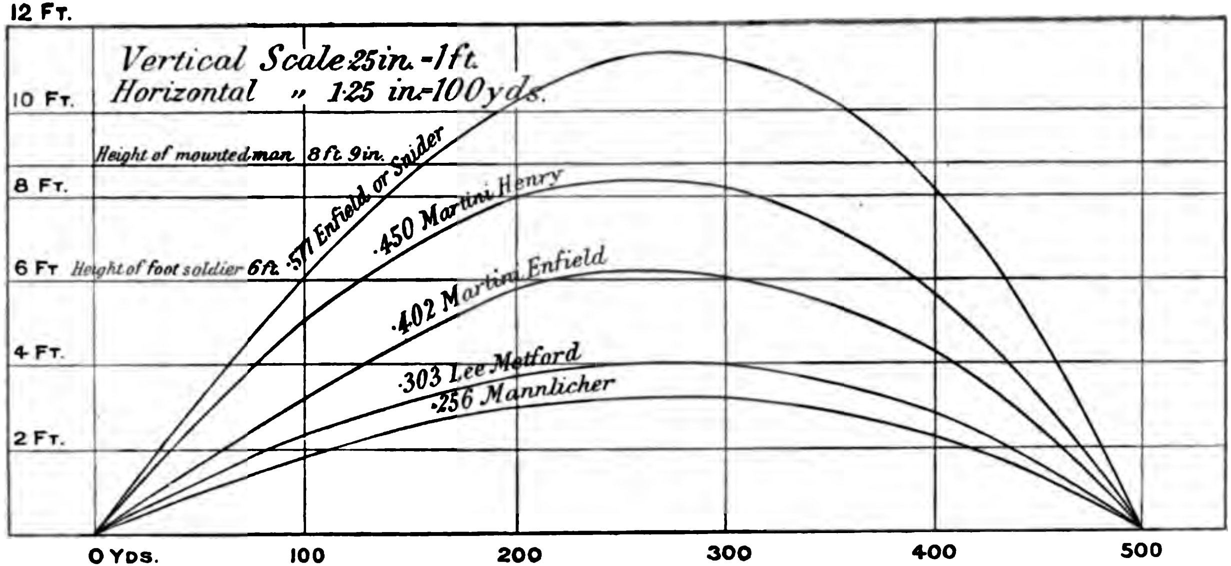
'*Example.*—Find the angle of descent of the Lee-Metford bullet at 1,000 yards range.

'Referring to the Table of angles of elevation, second column, $\frac{1000 \times (13{\cdot}804+15{\cdot}094)}{200}-\frac{13{\cdot}804+15{\cdot}094}{100}=144{\cdot}49'$ $-{\cdot}289=144{\cdot}201'=2°\ 24.201'$, which is the mean angle of descent for the last yard.'

Plates XL and XLI show the comparative heights reached by the bullets of military rifles in a flight of 500 and 1,000 yards.

Similar diagrams have often appeared, but a comparison of the kind is vital to an appreciation of what modern rifles are when compared with the more ancient ones, the object being to represent the form of the curves made by the different bullets. The height has been enormously exaggerated in proportion to the length of the curve. In the 500 yards diagram (Plate XL, fig. 1), whereas on the vertical scale a quarter of an inch represents a height of one foot, on the horizontal scale a quarter of an inch represents 60 feet, and the whole 500 yards is compressed into a little more than 6 inches. The curve made by the Enfield or Snider bullet is, as will be seen at once, the highest, reaching in the 500 yards flight a height of 11 feet 4 inches, well above the height of a horseman's head, while for the middle 300 yards of its flight it is too high to catch a six-foot man standing upright. The trajectory of the Martini-Henry, ·450 bore, with a bullet of 480 grains, and an initial velocity of 1,300 feet per second, culminates at a little beyond 250 yards at a height of just under 8 feet 6 inches, so that its whole flight is within the height of a mounted man, and for only about 150 yards would it fail to endanger an infantryman. The trajectory of the ·402 [experimental] rifle is similar on the whole to that of the Martini-Henry, but decidedly flatter. The two lower curves offer a striking contrast to the upper ones. The bullet of the Lee-Metford, ·303 bore, weighing 215 grains, and projected with a velocity of 2,000 feet per second, rises only just over 4 feet from the line of aim in the same distance, and would therefore strike the kneeling figure of a man at any point in the whole trajectory. The ·256 Mannlicher, with a bullet of 156 grains, and 2,350 feet velocity, rises not much more than 3 feet in the same distance. We have to guard against the error of supposing that because the curve is a constantly increasing one it is, with the high velocities of modern times, one of which the angles really are extremely steep. The necessity of exaggerating in diagrams the height of curves in relation to their length, as well as the habit the eye has of judging the trajectory of a bullet, which it cannot

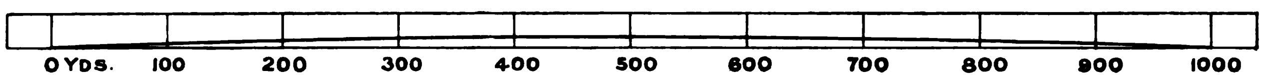
FIG. 1



TRAJECTORIES OF RIFLES AT 500 YARDS

N. B. The Vertical Scale is much exaggerated.

FIG. 2



TRAJECTORY OF ·303 RIFLE AT 1000 YARDS IN ACTUAL PROPORTIONS.

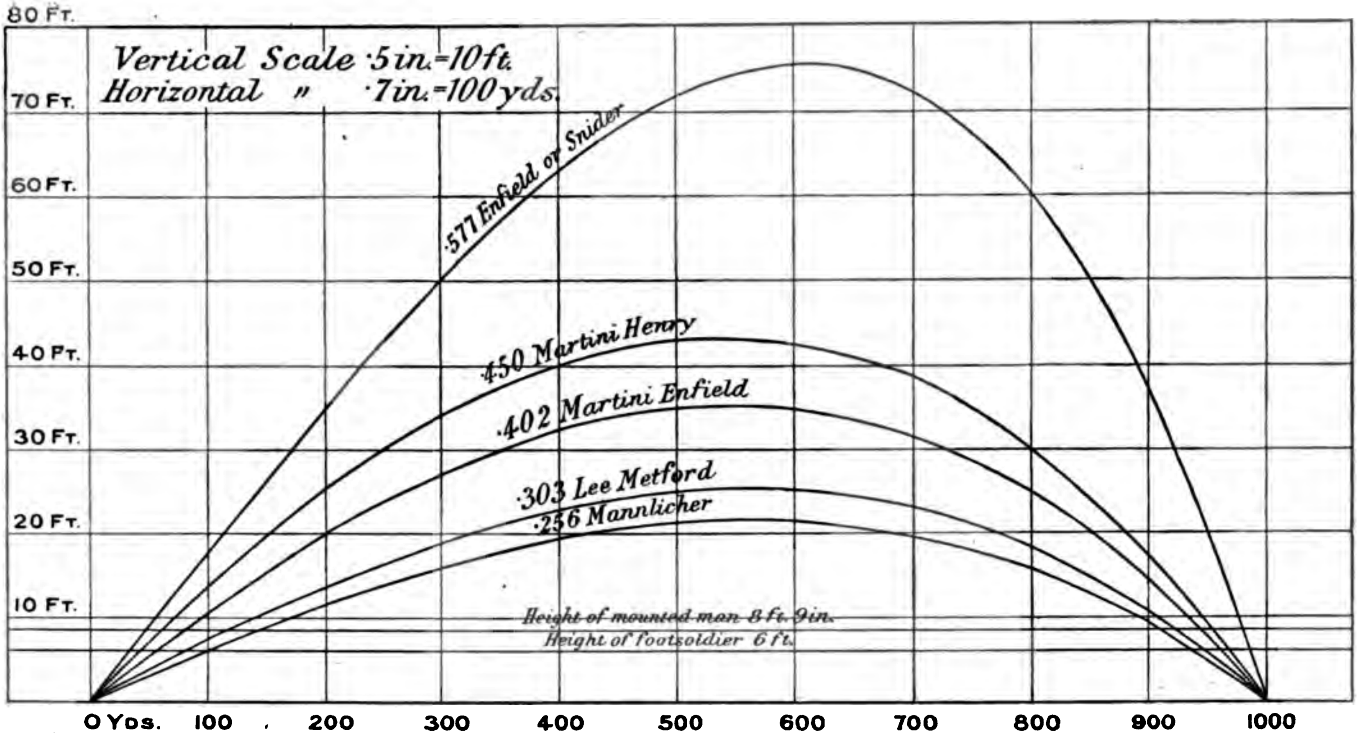
Scale, 100 Yards = ·7 in.

easily follow, by analogy from that of a cricket ball or a golf ball, which it can follow, tends to mislead the perception of the true proportions of the curves of bullets. The whole trajectory of the ·256 rifle for the first 300 yards of its flight, although in every point it is a curve, would be contained in a straight 12-inch pipe, and the small diagram given (Plate XL, fig. 2) will give some idea of the real shape of the curve made by the ·303 bullet in a flight of 1,000 yards. Plate XLI shows similarly the trajectories at 1,000 yards. In it ·05 inch is equal to one foot vertically, but to 21·7 feet horizontally.

Flat as the curves are, yet the vertical height reached by the bullet in the course of its flight at the long ranges becomes considerable. The bullet of the Enfield muzzle-loading rifle rose more than 75 feet in a flight of 1,000 yards; the Martini-Henry bullet rises about 44 feet; the Lee-Metford bullet about 25 feet; and that of the ·256 rifle 21 feet only above the line of aim. In firing at 2,000 yards the Lee-Metford bullet reaches a height of about 195 feet, between 1,100 and 1,200 yards, the muzzle of the rifle being pointed no less than 170 yards above the mark aimed at. It is hardly necessary to say that the whole journey of the bullet along the curve of the trajectory is somewhat longer than the straight line joining the two extremities of its flight. The difference thus introduced is, in reality, very small. At 1,000 yards, with the Lee-Metford, the path of the bullet is less than one foot longer than the straight line, and at 2,000 yards it is about 2,005 yards.

A knowledge of the trajectory is sometimes useful, and may at times enable one to take a shot when some object apparently intervenes without really interfering with the flight of the bullet. The writer has more than once stalked and killed rabbits, firing under the belly of an intervening cow, because it was evident that the bullet would not rise so high as to touch it. He has several times seen the bull's-eye struck at 900 or 1,000 yards when the target was partly obscured by intervening cattle within two or three hundred yards of the firer or the target. In deerstalking, when it has been a question whether some slight intervening rise of ground or tussock would or would not be cleared by the

PLATE XLI



TRAJECTORIES OF RIFLES AT 1000 YARDS.
N.B. The Vertical Scale is much exaggerated.

bullet, he has sometimes found a knowledge of the traject useful, though with the high-velocity rifles it approacl as we have seen, a straight line at the shorter ranges. must never be forgotten that the trajectory starts from bore and not from the line of sight, and that heather or gr may really be in the course of the bullet close to the mu when the aim is unobstructed. The writer believes that miss otherwise inexplicable, sometimes occur from a want of c in this respect. It is a liability to be taken into account wh firing from near the ground level, and, if the heather grass be long, it is sometimes worth while in shooting pro to prop up the elbows by any extemporised means to avoi the chance of the bullets grazing.

When the angles are known there is no difficulty abou ascertaining the height of the bullet at a given distance i the trajectory. Thus with the ·303 and the service charg the angle of elevation for 200 yards, as given in the table, is 9·6′. This means that the rifle at the moment at which the bullet quits the muzzle is pointing 20·22 inches above the point it will hit at 200 yards. In other words, the bullet falls 20·22 inches in that distance. Now the angle for 100 yards is 4·4′, which at 100 yards is equal to 4·61 inches. It is clear then that in the course of its 200 yards flight, when the bullet has flown 100 yards it will have fallen 4·4′ of the angle of 9·66′ with which it was projected. The value of the whole of this angle at 100 yards is 10·11 inches, and deducting 4·61 inches for the fall in the first 100 yards, it is evident that the remainder, 5·5 inches, will be the height of the bullet above the line of aim, supposing, that is, that the line of aim passes through the axis of the bore at the muzzle of the rifle, for a slight correction, inappreciable at long ranges, has to be made for the height of the fore sight above the barrel. The rule, then, for finding the height at any point in the trajectory is as follows:—From the angle for the whole distance deduct the angle for the shorter distance in question, and convert the remainder into feet and inches at the shorter distance. In making such calculations it is convenient to take as a basis the fact that one minute of angle equals 1·047 inch at 100 yards. This

inches above line of sight at en
n on page 293

t, 215 grains

D	1,500		1,600		1,700		1
in.	ft.	in.	ft.	in.	ft.	in.	ft
4·0							
6·5	29	1·8					
8·3	60	4·6	33	3·7			
9·9	93	8·9	68	10·7	37	9·7	
0·3	129	3·7	106	9·9	78	1·4	
3·9	167	1·6	147	2·2	120	11·9	
9·7	207	3·5	190	0·2	166	6·0	
6·3	249	10·2	235	4·8	214	8·7	
6·4	294	10·2	283	4·9	265	8·8	
10·7	342	4·6	334	1·3	319	7·2	
8·0	392	6·0	387	6·8	376	4·8	

method is very simple, and although it would not be sufficiently accurate for use in dealing with very high angles, it may be taken as absolutely correct for the flat angles used in rifle-shooting. So far as the writer has been able to check it by firing up to 1,000 yards through screens of very thin paper he has not been able to detect any error in the trajectory as thus deduced from the table of angles. A complete table of the trajectory of the ·303 rifle with the service charge, calculated from the angles, for all distances up to 2,500 yards, is appended. It will be found to be closely correct in fact, even if the velocity of the charge used is a little lower than the 2,037 feet per second, which was found to be the velocity of the particular Service ammunition with which the angles of elevation were determined some years ago. The mean standard velocity of the ·303 is now 2,000 feet per second as against 1960, at which it had stood for some years previous to 1901. A similar table for the Mannlicher rifle with a standard load is also appended, but it extends only to 1,000 yards, as the writer has not had an opportunity of collecting data on which to base an extension of it to really long ranges.

Trajectory Table of the Mannlicher 6½ *mm.* (·256) *Rifle, giving the height of trajectory in feet and inches above line of sight at every* 100 *yards to* 1,000 *yards*

Initial velocity, 2.350 f.s. Weight of bullet, 156 grains

Range in Yards	100	200	300	400	500	600	700	800	900	1,000
	ft. in.	ft. in.	ft. in.	ft. in.	ft. in.	ft. in.	ft. in.	ft. in.	ft. in.	ft. in.
200	0 4·2									
300	0 9·2	0 10·0								
400	1 3·1	1 9·3	1 5·6							
500	1 9·9	2 11·4	3 2·1	2 3·3						
600	2 5·7	4 3·1	5 1·6	4 10·7	3 3·3					
700	3 2·8	5 9·2	7 4·8	7 10·9	7 0·5	4 6·3				
800	4 0·9	7 5·4	9 11·0	11 3·2	11 2·9	9 6·7	5 10·5			
900	5 0·2	9 4·1	12 9·1	15 0·6	15 11·6	15 2·8	12 5·9	7 6·8		
1,000	6 0·8	11 5·3	15 10·9	19 3·1	21 2·8	21 6·6	19 10·3	15 11·8	9 5·6	0 0

The extreme range of the ·303 rifle is very little greater than that formerly obtained with the Martini-Henry. With the ·303 it is put at from 3,500 to 3,700 yards with an angle of elevation of about 29°. The experiment is not a particularly easy one to make, since, except in the very calmest weather, and under the most favourable conditions, there is great difficulty in finding where the bullets descend. Probably the easiest way of determining the point, if it needed to be done afresh, would be to mount a Maxim gun so that the barrel could be elevated precisely to any given angle, and to fire rapidly a few groups of shots. These would be much less difficult to locate, and at the same time would be more precisely directed, than shots fired by individuals. The rifle now used in the British army, the sighting of which extends to 2,800 yards, is the only European weapon sighted for quite such a long distance, though some of the Mauser and Mannlicher rifles used in other countries are sighted to 2,400 yards. It is said that at the siege of Ladysmith, a picked party of the Rifle Brigade more than once silenced a Boer gun at 2,900 yards, and the feat is quite possible if we take into account the good atmospheric conditions which usually prevail in South Africa, and the very great objection of the Boer gunners to remain in a neighbourhood in which bullets were falling. Such a feat could only be possible under quite exceptional circumstances. If it be remembered that in a flight of 2,500 yards the bullet rises almost 400 feet above the line of aim, it can easily be seen how susceptible it is to any influence of the wind, which, as already mentioned, is in more rapid motion at high than at lower levels.

The shape of the fore part of the bullet is naturally a leading factor in its maintenance or loss of speed. The form of bullet introduced by Mr. Metford, with a long sloping shoulder and a blunt point, was found to give a very appreciable advantage in angle over the more rounded form commonly employed up to that time. In America, a bullet with a very long curved fore part, ending in a rather sharp point, had been used for match shooting, and by adopting a rather similar curve from the cylindrical part, and rounding off the end without prolonging it to a point, the chief advantages of this shape are retained. The resistance of the air tends to make flat-headed shot fly true, but it is at an enormous cost in reduction of speed. A flat-headed shot used by Sir Joseph Whitworth with some success in piercing a ship's side under water is shown in fig. 75. This form of shot was found to penetrate the water, and not to glance off it, like ordinary pointed shot. The best theoretical shape for penetrating air with the least resistance has a sloping stern to it as well as a bow, but the attempts of Sir Joseph Whitworth to make use of this form in projectiles for big guns have not been followed up, and the shape introduces certain practical difficulties. Fig. 73 shows the Whitworth shot with tapered rear, and fig. 74 a tubular bullet of which he thought highly, finding it to give great penetration and to cut a core out of elastic substances. In 1893, some sensation was caused by

FIG. 73

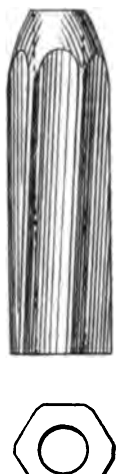


FIG. 74

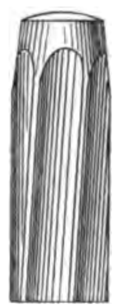


FIG. 75

the production of the Krnka-Hebler tubular bullet, which had long curved lines towards bow and stern, and which was solemnly announced to maintain its velocity and penetration in a wonderful degree up to extreme ranges; unfortunately it was not found to stand the test of actual experiment in these respects.

The difference in shape introduced by Mr. Metford will be seen if the ·303 bullets on p. 142 are compared with that of the Martini-Henry on p. 71. Any economy in air-resistance is effective more and more as the range increases.

The bullets of the ·303 rifle do not ricochet off turf at

3,000 yards, and very few of them beyond 2,000 yards. At distances approaching the extreme range of the rifle, the impulse of projection is largely exhausted, and the velocity with which the bullet strikes is due in part to its speed of fall under the influence of gravity. But it has little penetration. The direction of ricochets from a smooth surface such as calm water, naturally follows that of the spin, but on ordinary ground it is very uncertain.

CHAPTER XII

MOVEMENT OF THE RIFLE IN FIRING—ITS VIBRATIONS—EARLY IDEAS AS TO PATH OF PROJECTILE—THE TERM 'POINT BLANK'—JUMP AND FLIP—EFFECT OF BOLT FASTENING ON DIRECTION OF FIRE—AND OF AFFIXING BAYONET—EFFECT OF VIBRATIONS ON ACCURACY—COMPENSATORY ACTION—FRICTION IN THE BORE—FIRST SHOT FROM CLEAN BARREL—SHAPE OF BULLET-HOLE—SPIN OF BULLET—ITS STABILITY—RATE OF SPIN—PICTURES OF BULLETS IN FLIGHT—AIR WAVES—BULLETS VISIBLE IN FLIGHT—DRIFT—INFLUENCE OF EARTH'S ROTATION—GROUPING OF SHOTS—THE BALLISTIC PENDULUM—THE ELECTRIC CHRONOGRAPH

In the skirmishing kind of fire so often necessary on service, which approximates to fire under sporting conditions, and which is likely to be much more the rule in future than hitherto, the positions depend very much on the form of the ground, and on the circumstances of the moment. It is of practical importance always to rest the rifle, if this can conveniently be done. The Volunteers in Plate XLII, which has been taken from a little book published by Ackermann forty years ago, illustrate this point, though the trees from behind which they are firing would not in these days afford complete protection. The marksman whom Ezekiel Baker depicts shooting in the prone position (Plate XXX) has taken off his tall plumed hat (no doubt so made that the crown is of a convenient height for this purpose), and, having placed it on the ground in front of him, rests his rifle upon it. Such assistance in steadying the aim requires to be used with discretion. It is as well not to rest the rifle nearer the muzzle than can be helped. The normal movement of the rifle under the influence of the recoil, which begins before the bullet leaves it, and which is taken into account in sighting it when fired in the ordinary way, is apt to be disturbed by any support or restraint, and it may be that a slightly abnormal flight of the shot will be the consequence, which will lead to failure if great accuracy is essential. The ordinary military rifle does not seem to be easily disturbed in this respect, if rested near the middle of the fore end. It is a matter of common knowledge that in a double rifle or gun, the two barrels have to be set so as to converge somewhat towards the muzzle, and that if they are carefully examined the axes of their bores will be found, if prolonged, to cross at a little distance in front of the muzzle. The outward movement of the recoil, which swings the muzzle to the right when the right barrel is fired, and *vice versa*, compensates for this convergence, and the barrels, if properly adjusted for a given charge, will shoot parallel to each other. The sighting of a rifle is similarly disturbed by any appreciable variation from the normal charge. It may even be that by reducing the charge it will at a short range be found to shoot higher, and by increasing it to shoot lower. It is important, then, that the sighting of a rifle should be checked if there is any variation of the charge, either in the weight or composition of the bullet, or in the amount or nature of the explosive. If the barrel were free to recoil precisely in the direction of its own axis, and if the centre of gravity of its mass, with the fittings attached to it, were in the axis of the barrel, or in the prolongation of it, we may suppose that it would shoot quite normally, and that its sights would be correct, if their base line, or zero line, were made parallel to the axis of the bore; but it may be said that the correct line of sighting never fulfils these conditions. It is well known that in a pistol, or revolver, the fore sight is a good deal higher above the barrel than the back sight, to compensate for the upward kick which takes place before the bullet leaves the muzzle. With the longer barrelled rifles the vibrations are more complex, and the line of the zero may diverge either above or below the line of the axis of the barrel when at rest. In the Lee-Metford there is normally an upward throw of about 20′ to 25′, hence the necessity for a high fore sight.

It is evident that a long barrel when under the influence of the explosion of the powder is thrown into a state of vibration, the length of the waves of vibration depending upon the proportions of the barrel. This is truly the case with an unsupported barrel, but the vibrations seem to be checked and modified when the barrel is attached to a stiff and heavy fore end. If the barrel be supported at one of the nodes of vibration its free movement will not be interfered with, and,

VOLUNTEERS SKIRMISHING, *circa* 1861

indeed, if it be supported by a rest at a point at which it is lifted by the wave movement set up, it does not seem that the delivery of the shot is affected. But if the barrel be supported in such a way as to check its first vibrations, the direction of the flight of the bullet will be modified. If the fore end be removed from a military rifle the vibrations of the barrel, and indeed the movement of the whole rifle will, with the normal charge, be such as to require an entirely different sighting. Similarly an alteration of the proportions of the barrel by cutting off an inch or two at the muzzle may affect the sighting considerably. We have heard of an experiment with a sporting rifle having a short fore-end, in which different lengths of barrel were tried by cutting an inch at a time off the muzzle. Each alteration of an inch altered the sighting considerably at 200 yards, the bullet being thrown higher or lower. The want of appreciation of this fact of the movement of the barrel before the shot leaves it, gave rise to one great fallacy which adversely affected the science of shooting for hundreds of years. It was natural to suppose that the barrel would be correctly sighted for the shortest distance if the sights were arranged so that the line of aim was strictly parallel to the bore. This principle could not but apply to cannon as well as to the rifle. Now it would seem that with the older arms, in which the stress from the charge was not very severe, the ball was almost always delivered from the muzzle in a line higher than that of the axis of the barrel, and therefore of the sighting, and that it would fly some distance before descending again to that line. It was found that a gun or rifle carefully sighted and carefully aligned, threw its ball quite a considerable distance before it fell below the line of aim. The fact that it was not started correctly upon that line was naturally disguised by the comparative flatness of the initial portion of the trajectory. The theory had therefore to be made to fit the facts, and it seemed as if there must be a 'point blank' range, that is, a considerable distance traversed by the ball before it began to fall, or at all events, before it began to fall appreciably. This appears to have been accepted as a principle by gunners up to very recent times, although since the laws of gravity have been in any degree understood, it is clear enough that no projected body could fail to describe a curve. Leonardo da Vinci, who seems to have been almost as great a military engineer and man of science as he was a painter, clearly recognised at the end of the fifteenth century (as was pointed out in 1859 by Captain Jervis, M.P.) that the path of a projectile is a curve from beginning to end. But da Vinci's note-books were not published. The same fact was afterwards insisted upon by Tartaglia, who says, that except it be fired directly upwards or downwards a piece 'will not shoot fifty paces, nor yet one pace in a right line.' Yet Tartaglia, who puts in a strong claim to be the inventor of the gunner's quadrant or clinometer, is capable of maintaining in 1528 that if two shots are fired consecutively the second will travel further than the first, because 'it doth find the ayre not onely wholy stirred with the pellet of the first shoote, but also much tending or going towardes the place at which it is shot.' Nor was his scientific mind proof against that desire for the marvellous which is still much too common, for he gravely tells 'How a peece which had beene oftentimes togeather charged and discharged was made thereby so much attractiue, as that it did sodainlie drawe into his concauitie a little dog, which by chaunce did in going by, smell unto the mouth of the same peece,' and from this imaginary fact deduces a theory that after discharge there is some violent attraction or suction exercised by the barrel. William Bourne, in 1587, describes the beginning of the path of a shot as being a 'Right line, so long as the shot goeth violently,' and also says that 'point blanke is the direct fleeing of the shot without any descending from the mouth of the piece unto the mark.' Robert Anderson, in 1690, says of the first part of the parabolic curve, which Galileo had shown to be the path of the bullet, 'This line I call the line of Impulse of Fire, and take it for a right line for ease of calculation, although I believe the thing projected moves as it can so far as the Impulse of Fire or violent shaking of the Engin is upon it.' The term 'point blank' has been hard to kill. Sixty years ago W. W. Greener, in writing on the Science of Gunnery, defined it as being 'the distance to which the rifle will project a ball in a parallel line with the earth if a plain.' In recent times the expression 'point blank' has often been used, and is mostly taken to mean the distance which a bullet travels before it has dropped any appreciable amount. The word is thus used with great latitude, for it is purely a matter of taste, and sometimes of the necessities of advertising, whether the trajectory be considered straight for practical purposes up to 100 yards, or up to 600 yards or more. The fact is that the expression 'point blank' is one based on a fallacy and incapable of accurate definition. It has no place as a scientific term, nor has it definite meaning enough to give it any utility. The sooner it is recognised as an anachronism, and entirely abandoned, the better. Mr. Van Dyke maintains that it is worth while to keep the term, and defines it for practical purposes as 'that distance at which the ball will strike the regulation bull's-eye for that distance without rising in its flight.' Such a definition is necessarily vague, and conveys very little. Hardly any two people would attribute precisely the same meaning to the expression.

The confusion of ideas expressed in the term 'point blank' is, as regards sporting rifles, much emphasized by their being usually sighted so as to shoot a little high for the nominal range. Supposing that a ·303 rifle, instead of being accurately sighted for 100 yards, shoots 2 inches high at that distance, then the point where the ball really crosses the line of aim will be some 40 yards further on, and the delighted owner, if not something of an expert in these matters, will declare that the bullet from his rifle does not drop appreciably between 100 and 150 yards. One of the snares to which we are most liable is to attribute special and abnormal excellence to some favourite weapon without remembering that while one rifle may shoot more accurately than another the laws of gravity and air resistance are the same for all. The writer remembers one marksman of great gifts, and very prominent for a few years at the long ranges, who seriously maintained that he had a rifle which did not require any alteration of elevation for change of direction of the wind. Yet, though he seemed perfectly convinced of this, he knew better than to state it for a fact in a book on the subject of shooting which he afterwards wrote.

We have digressed somewhat from the subject of the movement of the rifle before the bullet leaves it as affecting the sighting. Experiments have been made on the matter in this country by Captain Close, R.E., and in America by Dr. Crehore and Dr. Squier, the method employed being to obtain photographs showing the course of certain points on, or attached to, the barrel. These go to show that as ordinarily fired in the hands of a man the whole rifle moves about an eighth of an inch before the bullet quits the muzzle. Indications are also obtained of the bending of the barrel under the stress of firing. Investigations on the same subject have been made by Messrs. Cranz & Koch, at Stuttgart, in 1899–1900. They have dealt very completely both with the movements of the different points in the length of the barrel and the effect on these movements of variation in the charge, and have also tried the effect of varying the degree of resistance opposed to the recoil of the rifle. Mr. A. Mallock, C.E., in a paper read before the Royal Society in June, 1901, on the 'Vibration of Rifle Barrels,' has dealt with the subject from the mathematical point of view, basing his calculations on observation of the whole rifle as a vibrating system.

It seems clear that the fore part of the barrel is vibrating with definite periods, especially in a vertical line, or, rather, in a line passing through the centre of the charge and the centre of gravity of the rifle, which is not always vertically below it, and that the rifle as a whole moves into the general upward kick due to the fact, firstly, of the centre of gravity of its whole mass being below the plane in which the backward pressure of the powder gases is applied; and, secondly, to the resistance of the shoulder, also at a point below that plane. The general movement round the latter point, which throws up the muzzle of the rifle some 4 or 5 inches, does not take place until after the bullet has left the barrel, until, in fact, the rifle has recoiled something like half an inch. It is well, as pointed out by Mr. Tippins, to distinguish the general movement of the rifle as 'jump,' from the first movement of the barrel usually downwards, called 'flip.' It is not only in a vertical plane that the rifle can move. The whole weapon receives from the bullet a twist corresponding with that given to the bullet by the rifling, although the movement is not really developed until after the bullet has quitted the muzzle. This phenomenon of the rifle, as distinct from the shot gun, may be distinctly noticed by the observant firer. If the weapon be held loosely at the moment at which it is discharged it will be found to have a slight tendency to turn in the hands in a direction opposite to that of its spiral. The toe of the butt tends with a right-handed spiral to move to the right, as it rests against the shoulder, and with a left-handed spiral to the left, simultaneously with the recoil. Deane even mentions the twist of the rifle in the hands on firing as one of the objections to a rapid spiral. The barrel can also receive a sideways vibratory impulse if there is any unevenness in the resistance offered by the breech to the recoil.

In the modified Lee action of the ·303 rifle the lugs which lock the bolt when the breech is shut, and which sustain the stress of the explosion, are more than 4 inches behind the base of the cartridge, and the action is of unequal strength and stiffness on the two sides; consequently, under the stress of the explosion an uneven sideways movement, although of very small amount, takes place, and this is enough to affect the straight delivery of the bullet. It must be confessed that it is not a good mechanical principle that the greater part of the length of the bolt should be subject to compression, and a similar length of the action to the opposite strain tending to elongate it, when, if the lugs locking the bolt are placed, as in some other patterns of magazine rifles, as close as possible behind the cartridge, undue cross strains can be avoided, and as little metal as possible involved in resisting the explosion. The objection to having the resisting shoulders for the lugs immediately behind the cartridge, is that this arrangement interposes an extra length of the metal of the action behind the chamber when the breech is open, and it is a little less easy to clean and to inspect the chamber and the bearings. It is found that if the two lugs and their resisting pieces are not quite accurately made, the sideways throw of the rifle may be considerable. If one lug bears when closed, and the other is two or three thousandths of an inch clear in front of the bearing that should support it, so that it only comes to bear after a certain amount of pressure has been put upon the bolt, the sighting will be affected to the extent of several inches at 100 yards. The effect of these inequalities on the sighting have only recently been sufficiently appreciated. Mr. Tippins first drew attention to their effect upon the sighting, and Colonel Watkin, the able head of the Small Arms Factory at Enfield, independently arrived at this cause of lateral variation in the shooting. It seems clear that in the same rifle the amount of side-throw will vary with the different charges used. The mass of the rifle is not quite symmetrical, especially when it has a projecting bolt handle. The writer has found a very decided tendency with the ·303 rifle to require a different lateral adjustment with cordite from its sighting with black pellet powder, amounting to about 4 minutes of angle when shooting prone, but rather less in other positions. Contrary to common belief, a steel barrel not only can bend, but is extremely sensitive to any cross strain. The barrel before it is grooved is 'set up,' that is, it is adjusted, if necessary by blows of a hammer, so that the reflection of light down its whole length shows it to be, so far as the human senses can tell, absolutely cylindrical and straight, yet it can be seen to bend, as has been previously mentioned, under comparatively slight cross strains. It is probable that the standard of straightness insisted upon for Government arms in this respect is unduly high, for when the barrel is fastened at two points, if not along its whole length, with a rigid fastening to the stock, it is practically certain to have permanent cross strains put upon it. In any case it is clear that the explosion of the charge in a barrel must and does establish very great vibration, so that on the whole it is a matter for astonishment that one shot after another can be delivered with so little variation of the movement of the rifle as is actually possible.

If it were necessary to bring home to the incredulous the fact of the influence of any unusual stress on the rifle, and especially on the barrel, upon the direction in which the bullet is discharged, it would only be necessary to instance the effect of attaching the bayonet. This in the Martini-

Henry rifle was fixed to one side of the muzzle, and the bullet was deflected towards the opposite side. In the ·303 the bayonet is fixed underneath the muzzle, and, owing to the different proportions of the rifle, the shot is thrown something like 8′ or 10′ (minutes of angle) below the ordinary line of sighting in consequence. The precise amount of this effect of the bayonet when fixed is not constant, for there are always peculiarities of particular rifles as well as variations in the fitting of individual bayonets.

It is certainly the case that the movement of the barrel on firing is to some extent influenced by the degree of tension of the metal of which it is made. Mr. Metford found that he could produce the wildest shooting by setting up a state of strain in the barrel by torsional stresses before firing, if it were rigidly fixed in a vice. When by the application of fresh forces the barrel was set free from the torsional strain, the ordinary vibrations due to the explosion were complicated by the movement of recovery.

It will be better understood now how important it is to be careful about the amount of support which the rifle may receive from some convenient rest in firing a shot. This applies no doubt more to sporting rifles, which have the barrel unsupported for a great part of its length except by its own substance, than to full-stocked military rifles, but it is a factor not to be neglected under any circumstances. In sighting a rifle from a table rest the writer has usually found it satisfactory to have a sand-bag or some similar support against which the left fore-arm and hand could be rested, rather than to have a special arrangement for supporting the barrel towards the muzzle. In firing without a rest it is important to keep the grip of the hands and the pressure of the shoulder on the rifle as even as possible. In the back position the barrel of the rifle should not touch the left leg for one shot and at another be clear of it. The position of the body should not vary, and care should be taken that it rests on exactly the same spot of ground for each shot of a series. Under no circumstances should any part of the rifle touch the ground.

Granted that the muzzle of the rifle is put into a state of vibration before the departure of the bullet, it is evident that the point in the course of the vibrations at which the bullet will quit the muzzle may vary. If the bullet be delivered while the muzzle is actually moving (let us say) upwards, some slight irregularity in ignition or in friction tending to retard its movement, though only for the minutest fraction of a second, will lead to the bullet leaving the muzzle at a slightly higher angle than the normal. The reverse will be the case if, at the instant at which the bullet leaves, the barrel is moving downwards. It seems evident that the effect in this respect of any irregularities will be minimised if the point of the vibration during which the bullet leaves the barrel is either the highest point at which, having ascended, the muzzle is, as it were, halting momentarily in order to descend, or the lowest point, at which these conditions are reversed. It might therefore be well in designing a rifle to arrange that the charge and the length of the barrel should be such as would cause the exit of the shot when the vibration was at an extreme. Or it might equally be advantageous to arrange for the exit of the bullet to be at such a period as would cause it, if delivered with a velocity somewhat below the normal, to be directed at an angle slightly above the normal elevation ; and conversely, if endued with a velocity higher than the normal, to be delivered at a slightly lower angle. If the patient reader has been able to follow the last few sentences he will understand that it should be possible in this way to introduce a compensating element for the variations in velocity of individual shots which, although at the nearest ranges it might somewhat exaggerate their deviations, would at longer ranges automatically do much towards correcting them. Sir Henry Halford was convinced that some such automatic compensation takes place in the ·303 rifle with the Service charge. The writer has often noticed in firing at a ballistic pendulum at 12½ yards to ascertain the velocities of a series of shots, that, with the ·303, shots the velocity of which is considerably below the normal, strike high, and those above the normal low. It would seem as if some considerable part of the accuracy at long ranges of the Service rifle must be due to this compensation. For so far as the writer's own experiments with the Service ammunition have gone, they have not proved its capacity to achieve merely from the regularity of its shooting with the Service charge the results which it is possible to obtain from it at long ranges. Mr. Mallock shows that an error of *plus* or *minus* 40 f.s. with the Service rifle would lead to the following results. Supposing the barrel to recoil horizontally, and that there is no jump, the variation of the trajectory will be as follows:—

At	100 yards *plus* or *minus*	·14 feet
„	500 „ „ „	1·17 „
„	1,000 „ „ „	3·8 „
„	1,500 „ „ „	7·8 „
„	2 000 „ „ „	13·8 „
„	2,500 „ „ „	23·0 „

If on the other hand the shots of *minus* 40 f.s. velocity are directed 6′ (minutes) above the normal, and those of *plus* 40 f.s. 6′ (minutes) below the normal angle, the result is as follows:—

At	100 yards *plus* or *minus*	·38 feet
„	500 „ „ „	1·70 „
„	1,000 „ „ „	1·26 „
„	1,500 „ „ „	0·00 „
„	2,000 „ „ „	3·15 „
„	2,500 „ „ „	9·8 „

It is plain enough here that upon the given supposition the effect of the movement of the barrel, while it increases the error at 100 and at 500 yards by a small amount, absolutely compensates for it at 1,500 yards, and enormously reduces it at 2,000 and 2,500 yards. It is well worth the attention of scientific men interested in rifle work to attempt to develope this side of the problem, that so far as possible the inevitable irregularities of the shooting may be made to balance each other. It used to be found with the old Match rifle that some barrels were much more sensitive than others to a small variation of charge, and the writer remembers Sir Henry Halford speaking of a rifle of his which could be depended upon to hit the target at 1,000 yards without alteration of angle when the charge of powder was varied within reasonable limits. The movement of the barrel compensated at that distance for the variations in velocity.

There is one striking instance of the effect of the variation of friction in the barrel. With the rifles using black powder the first shot was fired under quite different conditions from later ones, because it had not to deal with fouling already deposited upon the bore. The effect of this was that the first shot from a clean or oily barrel was not normal to the subsequent shots fired. Consequently it was found advisable before entering upon a competition to foul the barrel of the rifle by firing a shot into the ground. 'Blowing off,' as this is called, was usually confined to a single shot, but this was not always thought to do everything that was required, and the more scrupulous or imaginative would fire several shots into the pit in order to bring the barrel to about the same temperature and condition as during a series of shots. It is not one of the least of the blessings of smokeless powder, so far as rifle competitions are concerned, that it has enabled the greater part of this trouble, which amounted to a nuisance, to be abolished. With the ·303 and Service ammunition it is found practically that the flight of the first shot is similar to that of the others, provided that the surface of the bore is dry and not greasy. This is the case at least at the short ranges. The experienced marksman has usually convinced himself that at long ranges, at which 'blowing-off' is still allowed by the Bisley rules, it is worth while to take advantage of the permission, and he knows that especially with rifles such as sporting rifles, in which there is no long fore-end to check the vibration, there is a liability to false shots unless the barrel is not only fouled, but warmed up to something near the heat it acquires at the ordinary rate of firing. The writer has often known shots go high after a pause long enough to allow the barrel to grow cold.

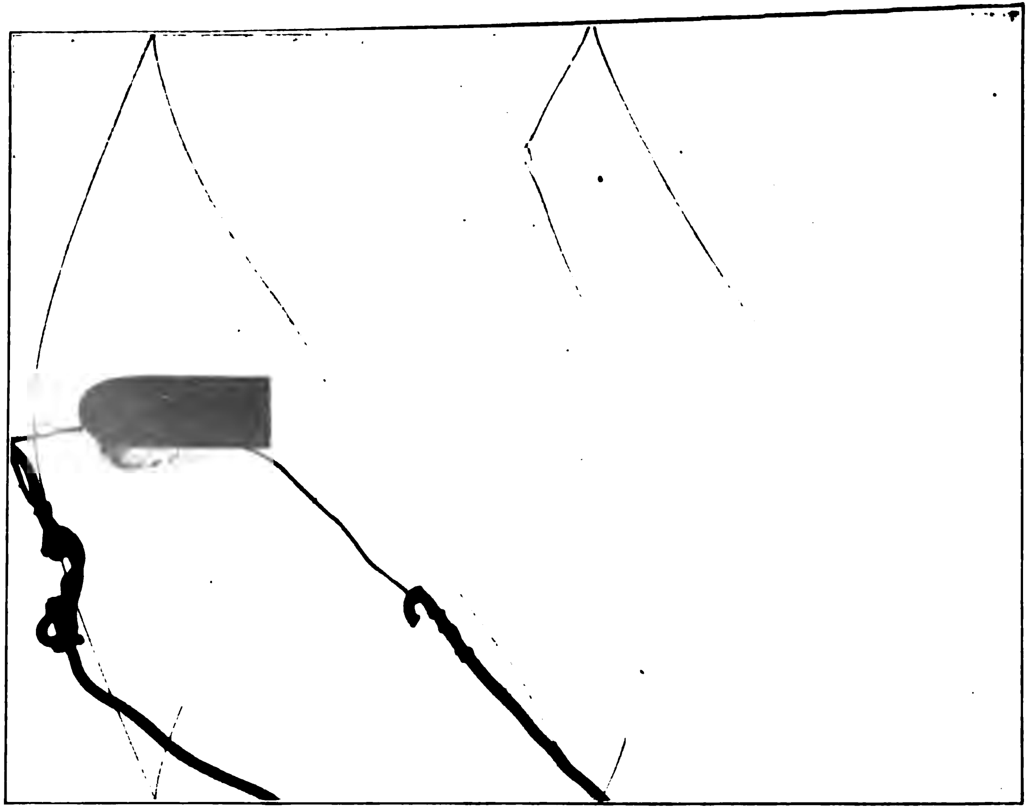
In firing at a cardboard target at short ranges to test or compare any form of loading, not only should the size of the group made by the shots be carefully scrutinised, as denoting the accuracy of the shooting, but the bullet holes should be examined to see that they are round and true. They will sometimes be noticed to be oval, and to have a dirty mark on one edge, where one side of the bullet has come in contact with them. This is a bad sign, although with rifles of small calibre firing long bullets it is difficult to find any form of loading in which it does not sometimes occur. It means that the bullet is not spinning truly upon its own axis, but is gyrating with its point and base each describing a circle. Such a flight must of course be irregular and lead to inaccuracy. The writer remembers some years ago trying a smokeless powder in a ·461 Metford Match rifle. Beginning cautiously, for one cannot be too careful with powder of unknown strength, the charge was increased from a very small one, which proved insufficient to spin the bullets properly, until it had arrived at a point at which the rifle made beautifully accurate shooting at 50 yards. On going to 1,000 yards, however, the bullets could not be induced even to keep consistently on the target. A small increase in the charge put this right, and the shooting at 1,000 yards was excellent. The obvious moral is that accurate work at 50 or 100 yards does not necessarily mean accurate work at long ranges. Yet the converse is, generally speaking, true. Anything like material inaccuracy at 50 or 100 yards means poor work at long ranges. In some cases the inaccuracy may be due to the bullet having an insufficient rate of spin upon it. It was found in penetration experiments in America some years ago with the military rifle, that when the velocity was brought down to about 1,000 feet per second to simulate the effect of the bullet at long range, the shots would not fly point foremost. Unless the rate of spin is very sufficient, there is sure to be deviation due to the instability of the bullet at long ranges. The bullet of the ·256 Mannlicher certainly has a strong tendency to 'key hole,' or make an oblong hole in a canvas target at long ranges. This may or may not be mainly due to such a cause. Generally speaking, the rate of spin which will suffice to start a bullet steadily upon its course without its being materially disturbed by the blast of the gases as it issues from the muzzle will keep it steady through any reasonable length of flight. When we speak, with the ·303 rifle, of the bullet making one turn in 10 inches of progressive flight, that expression is far from being accurate for the whole flight. If the bullet were to maintain the speed with which it left the muzzle of the rifle, it would continue to turn in exactly the same spiral; but its velocity falls off at once, and that very rapidly. The rate of spin, on the other hand, diminishes very much more slowly, and the consequence is that when the bullet has lost more than half its speed, it will still be spinning at more than half its original rate of spin. This being so, it will be making perhaps one turn in only 5 to 7 inches of progressive flight instead of the original 10. That this is the case may be noticed by anyone who has picked up a Lee-Metford bullet which has grazed upon sand after a flight of a few hundred yards. The pitch of the spiral marked on the sheath of the bullet by the sand has an entirely different inclination from that of the rifling marks. In firing at 2,000 yards, Mr. Metford found that the thin wooden target at which he fired marked the bullets at a very different angle from their original pitch. They began their flight with one turn in 16½ inches, and ended with one turn in about 6 inches of flight. Mr. John Rigby, the veteran riflemaker and shot, who for some years was Superintendent at the Royal Small Arms Factory at Enfield, relates a curious anecdote illustrating the persistence of the spin, which occurred within his own experience. On a short range on the roof of a gunmaker's factory in Birmingham there was a water-tank with a rubber panel at the side, such as is sometimes used for catching fired bullets uninjured. A shot had just been fired into it, and one of those present said, 'Hullo, there's the bullet,' and pointed out the bullet on the floor, not lying upon its side, but standing upon its end, spinning like a top. They all saw it; and he stooped down, stopped its spinning, and picked it up with his hand. It would be almost impossible intentionally to reproduce what had happened. Something had diverted the bullet; it had lost almost all its velocity in the water, but had issued upwards out of it, for the top of the tank was uncovered, and had dropped upon the floor. But though its velocity was gone, its spinning had not ceased, and it must have presented an astonishing sight as it stood on its end still retaining, within a very few yards of the spot from which it had been fired, much of the rotary motion which it had received along with a velocity of 2,000 feet per second.

The stability of a bullet in flight, if it start with an ample spin, is very remarkable. In the summer of 1901 Mr. Rigby recorded in the pages of the 'Field' a curious occurrence which happened in Ireland during long-range shooting on a range by the sea. As one of the shooters fired, a rook which was passing at a low altitude some 150 yards in front of the firing point was seen to drop dead. When picked up it was found that the bullet had struck the head fairly in the centre above the bill, and had split it so that it almost fell in two halves; nevertheless the bullet reached its destination, and the marksman scored a bull's-eye. The writer remembers once firing a series of shots at 900 yards, and making a fair score with every shot well on the target, and finding afterwards that one of the bullets had made a hole in a leather strap, which, being attached to a telescope supported on a low stand alongside the shooter, happened to have been swung by the wind in front of the muzzle, yet so far as appeared without affecting the flight of the bullet. Even with a small rifle firing a light charge it is much less difficult than would be supposed to bring down two rooks in the same tree, and some little distance apart, with one shot. If the further one is carefully centred behind the nearer, and the shot planted well in the middle of the nearer one, this double bag may be brought off, so far as the writer's experience goes, more frequently than would be thought possible.

From what has been said it is clear that when it has left the muzzle of the rifle, and especially in the latter part of its course, the bullet is spinning faster in proportion to its rate of progress, and is probably resisted to some extent on this account as it spins, because its section is no longer circular, but has impressed on it projections corresponding to the grooves. This is no doubt what Mr. Tippins alludes to when he speaks in his book, 'Modern Rifle Shooting,' of the bullet forcing a way through the air like a corkscrew, not screwed into a cork, but dragged through it. We would rather compare it to a corkscrew, which, as it goes into the cork, is turned faster than the normal pitch of the screw cut upon it would lead it to do, and so meets with additional resistance. It is not easy to say how far this degree of resistance will affect the flight of the bullet. Mr. Tippins considers that the difference in flight due to this cause between similar bullets fired from ·303 rifles, with concentric or segmental rifling, is very appreciable, and is decidedly in favour of the latter at long ranges.

We have spoken of the spinning of bullets as comparable to the spinning of a top. It will be interesting to give some figures as to what the speed of spinning really is with bullets of different kinds. The old Enfield or Snider rifle, which gave the bullet a velocity of 1,300 f.s., and had a spiral making one turn in 78 inches, spun the bullet 200 times per second. The Martini-Henry, with the same muzzle velocity, and rifled with one turn in 22 inches, gives a rate of spin of 714 times per second. The bullet of the ·303, moving at 2,000 feet a second, is spun no less than 2,400 times per second. The Mannlicher rifle, of ·256 bore, with a velocity of 2,400 f.s., and a pitch of spiral of one turn in 7·87 inches, gives the bullet a spin of 3,657 times per second. Nor is this all. Colonel Rubin's last experimental rifle of 6 mm., which has a velocity of over 2,600 f.s., if it has a spiral as rapid as that of the 6·5 mm. Mannlicher, must spin its bullet at the rate of more than 4,300 times per second. This is an enormous speed, but it must be remembered that in the course of one second the bullet flies more than 500 yards. A properly centred bullet makes no sound whatever in flight, but if Colonel Rubin's bullet were to hum like a top, setting up a vibration with each revolution, the note which it would give would be above the ordinary range of musical sounds, which Tyndall puts at from 40 to 4,000 vibrations a second.

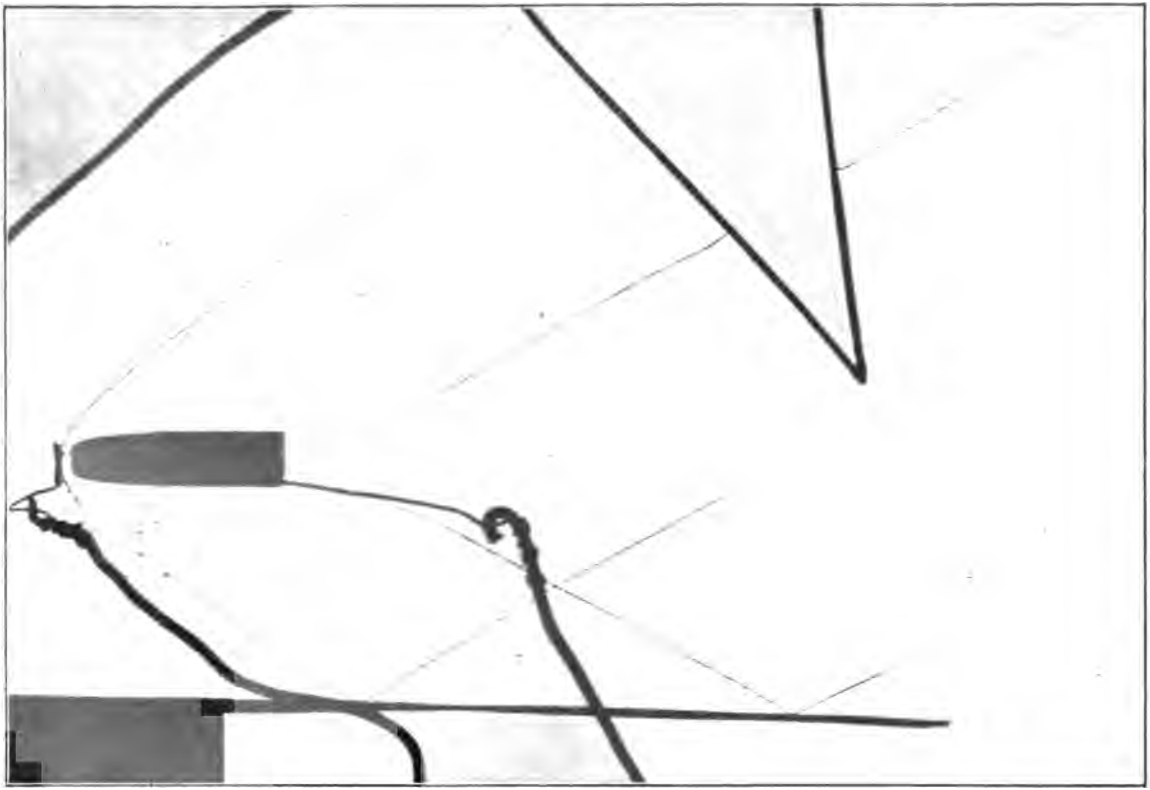
We are able by the kindness of Professor C. V. Boys, F.R.S., and of Messrs. Newton, of Fleet Street, to reproduce two of the skiagrams, or shadow-pictures, taken by him of bullets in flight. These pictures, which it has been necessary to reduce slightly in scale, are obtained by exposing a photographic plate in a dark box, and so arranging matters that the bullet in its flight makes a contact between two wires, and thus completing a circuit, causes an instantaneous spark to flash on the further side of the box opposite to the negative. The shadows of the bullet and its



MARTINI-HENRY BULLET IN FLIGHT, 1,296 FEET PER SECOND (REDUCED SCALE)

surroundings are therefore thrown upon the negative. The circuit of electricity is specially arranged so as to give a spark comparatively powerful in illumination, but of extremely short duration. The spark used in taking these pictures was so rapid as to last not more than one-twelve-millionth of a second. Very large figures convey no distinct impression to the mind, but some notion of what this period of time is may be gathered from the fact that it is rather shorter in relation to a whole second than a second is to three months. Plate XLIII shows a Martini-Henry bullet in flight. The sharpness of outline of the bullet is very remarkable. It has not moved sufficiently while the spark lasted to blur the picture at its nose or its base in the very least. The shadows of the leaden wires with which it is in contact are clearly seen, and the fragments of the wire which it has broken away and carried with it form an irregular cloud of small particles underneath it. The different densities of the disturbed air are distinctly reproduced in the shadow picture. In the rear of the bullet is a wake of disturbed air having the appearance of flocculent and broken matter flowing in to fill up the space behind the base. Three-eighths of an inch in front of its nose there is a line which defines the bow wave that the bullet carries with it. This is a wave of compression, and it is very clearly seen to be reflected from the surfaces at the top and bottom of the picture, and, crossing the wake of the bullet, to be reflected a second time. Air waves are only formed if the bullet is travelling at a higher rate of speed than the velocity of sound, 1,100 feet per second, and accordingly a photograph taken by Professor Boys of a pistol bullet travelling at the rate of 750 feet per second showed no wave at all. It will be observed that the irregularities on the surface of the bullet give rise to a minor series of waves. The Martini-Henry bullet in the picture is travelling at the rate of 1,296 feet per second, or about 830 miles an hour.

Plate XLIV shows a precisely similar picture of a Lee-Metford bullet moving at the rate of 2,000 feet per second. Here the bow wave is very conspicuous. It is inclined at a much sharper angle owing to the increased speed, and it is carried very much closer to the nose of the bullet. If the bullet were moving at a much greater speed than this, the inclination of the wave would be steeper still. Were it possible to photograph the same bullet after a flight of 1,000 yards with its velocity of little more than 900 feet per second, we should find that it made no wave at all. There is a very similar wave given off from a little distance behind the bullet from a certain point in the narrowing wake of disturbed air. The trail is much more conspicuously marked than that made by the Martini-Henry bullet, and it is clear that the air disturbance which it leaves behind does not settle down again for a considerable distance. The air waves shown in this picture have been purposely intercepted by plates of copper, and we see distinctly how they are reflected after meeting this surface, just as a ripple caused in very still water is reflected from the edges of a pool or basin. The cloud of broken fragments of the wire is again clearly seen below the bullet, but they are much finer, and evidently, as shown by the shape of the wave, they are travelling much faster than those broken up by the larger but slower bullet. A curious phenomenon may be seen in front of the bullet's nose. It has not yet touched the second wire, but the electric discharge jumps forward to meet it, as is shown by the lines of air disturbance between the two, and by the fact that the picture was actually taken by the spark caused by the completion of the circuit before the nose of the bullet reached the wire. In another photograph of Professor Boys' series the inclination of the axis of the bullet to the angle of the bow wave shows that the bullet was not flying true, but wobbling decidedly, since at the moment when the picture was taken it did not truly bisect the angle of air disturbance corresponding to the general direction of its movement. A full account of Professor Boys' experiments will be found in 'Nature,' March, 1893, and in Vol. 37 of the 'Journal of the Royal United Service Institution.' He proved quite clearly the fact, long suspected, that the bullet receives quite an appreciable increase of velocity after leaving the muzzle from the rush of the gases which follow it out of the barrel. It follows from this that the term 'muzzle velocity' is an incorrect one. The full velocity is not attained, it seems, till



LEE-METFORD BULLET IN FLIGHT, 2,000 FEET PER SECOND (REDUCED SCALE)

the bullet is a short distance away from the muzzle. Initial velocity, meaning the highest velocity attained in the beginning of the flight, is a more logical expression.

It is not difficult for the practised eye to see bullets in flight, although the small bullets of modern rifles are less easy to see than were those of earlier days, partly because they move much faster, and partly because they are much smaller. The writer knows a range where the target is set against a wooded hill, forming a dark background. Here, late in the day, it is sometimes possible to see the bullets, for the reflection of the sun on the base of them makes a brilliant little spot which shows distinctly against the dark background. On another range he remembers watching every bullet from the ·303 for a long series of shots. Some 50 yards in front of the firing point was a low hedge; the sun was shining, and the flash of the missile, a copper-clad one, as it crossed the dark background of the hedge made a brilliant line of light, which was very noticeable. The bullet of the Snider rifle, big in diameter, and moving at a low speed, could quite well be seen to curve downwards as it arrived at the target. It was always possible with a good telescope to see something of the flight of the bullet from the old Match rifle at long ranges. The telescope required to be pointed towards the upper part of the curve of the trajectory, so that the bullet should appear to rise into the field and to descend again. The bullet itself was clearly seen, and appeared to carry with it no air disturbance. Its velocity at the point at which it was seen was probably less than that of sound. The bullet of the ·303 is so much smaller as to be in itself less easily discernible, but owing to its high velocity it is accompanied by a column of air disturbance, making it quite conspicuous against any broken background. The appearance is that of a rippling curve of disturbed air, roughly perhaps a foot in diameter, which is seen to rise into the field of the telescope and to fall out of it again, the bullet itself being hardly, if at all, visible. This phenomenon may be seen under reasonably favourable circumstances by anybody, but to see the flight of the bullet with the naked eye is almost a gift; it certainly requires a particular knack, which cultivation can develope. Mr. Thorn, better known by his business name of Charles Lancaster, seems to have been the first to point out that the charge of shot from an ordinary gun can be seen in its flight through the air. Anyone with good quick eyes can acquire the knack of seeing a slow-moving bullet, and probably if the endeavour to see bullets in flight were more often made, we should hear of the power of seeing them being by no means uncommon.

It might have been thought that the retardation due to air resistance and the fall due to gravity were, if we except any movement of the atmosphere, the only causes which could affect the direction of flight of the bullet. This is not really so, for there is another motion which a bullet acquires in its flight, a sidelong tendency which follows the direction of the twist of the rifling, or rather that in which the bullet is spinning. This deviation from a straight path is known as 'drift.' At short distances it is slight, and indeed almost inappreciable, but it is quite disproportionately great at longer ones. The sideways path of the bullet is, in fact, a curve. With open or military sights it is possible to make allowance for it by arranging the sliding leaf of the back sight so that it has the required degree of lateral movement as it is raised to higher elevations. The writer has seen a back sight a good many years old in which the slide had a projection moving in a curved slot cut in one of the uprights of the back sight, and an almost precisely similar arrangement has quite recently been patented. An approximate allowance for drift at the various distances may be made by tilting the back sight 2 or 3 minutes of angle to the left for a right-handed spiral, and to the right for a left-handed one, and this is sometimes done in fitting the back sights of Match rifles. Where a spirit-level is not used in connection with the sights, the difficulty which arises in the field of correctly levelling them is so great as to obscure very much the effect of drift.

The actual cause of drift, which certainly increases at extreme distances out of all proportion to the range, is neither, as has been supposed, an effect of the reflection of air waves, or explosion waves, from the earth, nor does it seem to be mainly due to the rolling motion of the shot upon the air beneath it, though it may be partly due to this cause. The most widely accepted explanation is that it is caused by the upward pressure of the air upon the fore part of the bullet as it advances, and at the same time falls. This pressure upon a body in a state of gyroscopic stability such as is a spinning bullet tends to make its point deviate with a slow motion first to one side and then in a circle, and it would seem as if the first and chief motion, that to one side, were the cause of drift. But the subject is one upon which authorities differ, as was shown by the remarks of Professor Greenhill at a discussion on a paper read on the subject by Major-General Owen at the Royal Artillery Institution a few years ago ('Proceedings,' May, 1896). The lecturer by some experiments in 1862 and 1864 had established the curious fact that cylindrical projectiles drift in the opposite direction to pointed ones. It is very probable that the drifting motion may be a result of other causes in combination with the gyroscopic action, but this is most likely its main factor. There is still room for experiment on the subject. If Major-General Owen is right, it should be possible to make a projectile which should neither drift in the opposite direction to the spiral, like a cylindrical shot, nor with the spiral, like a pointed one, but, being shaped on a compromise, should at some given speed have no drift. It is hard to get very definite results from experiments on drift with the rifle, and experiments with big guns entail an expense almost prohibitive when the question to be elucidated is not of much practical importance. Mr. L. R. Tippins maintains that the amount of drift with a ·303 rifle is about 10 inches at 500 yards, and 4 feet at 1,000 yards. Mr. John Rigby puts it 10 inches at the latter distance. In the 1898 edition of the official 'Musketry Regulations,' it is said to be 11 inches at 1,000 yards and 23 inches at 1,200. The writer has no conclusive experiments which would enable him to judge between so many different opinions of great weight. It is clear in any case that the zero of direction will not be quite the same at 500 yards as it is close to the rifle, nor at 1,000 yards as it is at 500 yards. To give the correct direction for 1,000 yards, Match rifles are usually adjusted to shoot 2 to 3 minutes to one side at 12½ yards. It is, however, fortunate that the deviation from this cause only becomes noticeable when at ranges where the natural inaccuracy of the flight of any particular shot becomes considerable.

Far the commonest twist for rifles is the right-hand twist, that is, the direction of the spiral is similar to that of the thread of an ordinary screw, and on looking through the barrel from either end it seems to turn, as it recedes from the eye, in the same apparent direction as the hands of a clock. The Spanish Mauser, the French Lebel, and the English Lee-Metford and Lee-Enfield rifles, seem to be the only European rifles which have the spiral in the reverse direction. This was not done, so far as the British arm is concerned, without a purpose. It seems clear that the rotation of the earth has an appreciable effect upon the flight of the bullet, and that in this latitude in the northern hemisphere a bullet which is pursuing an absolutely straight course will deviate about 6 inches to the right in a flight of 1,000 yards in whatever direction it may be fired. This subject was, according to Walker (1865), investigated more than 40 years ago by various mathematicians, and especially by Paul de Saint-Robert. The conclusion come to is that the amount of deviation does not vary much with the direction in which the shot is fired. It attains its maximum when the shot is fired towards the south-east, and its minimum towards the opposite point of the compass. The deviation will be towards the left in the southern hemisphere. It was said to have reached a very appreciable amount, some 3 yards, in the case of Armstrong and Whitworth cannon fired at 5,000 yards. A paper on the same subject by Mr. Dalton, printed in the 'Journal of the Royal United Service Institution,' 1886, Vol. 30, No. 135, gives calculations leading to much the same result. The Small Arms Committee of 1886 was accordingly led to decide upon a left-hand spiral. It was maintained by Sir Henry Halford that with the Metford ·461 Match rifle at 1,000 yards the deviation of the bullet, due to the two causes in combination, was 3 feet 6 inches to the right with a right-hand spiral, but only 2 feet 6 inches to the left with a left-hand spiral of similar inclination, since by this effect of the rotation of the earth 6 inches were in the one case added to, and in the other subtracted from, the deviation due to drift. That the pressure of the air upon the bullet is very considerable at such high speeds as are attained by modern rifles admits of no dispute. It has been said that at a speed of 2,200 f.s. the resistance of the air amounts to 28 lb. to the square inch, and that, assuming a bullet of the size of the Lee-Metford moving at this speed through the air, it would meet with as much resistance as if it were moving in a vacuum with no air to oppose it, but were dragging with it a weight of 2¼ lb. It is the pressure of the air upon it which causes the bullet to keep itself constantly pointed in the direction in which it is moving; if it were moving in a vacuum, it would have no tendency to point in any other than its original direction, and after a long flight would fall with its nose well up in the air, keeping its position parallel to that which it had when it left the muzzle of the piece. This fact, that the axis of the bullet really follows very closely the curve of the trajectory, used to be doubted, and is even now not quite as well known as it should be, probably because at very low velocities the phenomenon is not noticeable. The writer has seen diagrams entirely misleading upon this point, in books written by those who had only a theoretical knowledge of the subject. At whatever distance from the muzzle the bullet may strike, it will be found in perforating such a body as a wooden target to make a round hole, if it has had sufficient spin given to it in the first place. This has been practically demonstrated with the rifle over and over again at distances of 2,000 yards and more, and with large shot fired from big guns it requires no elaborate proof, for it is obvious to the eye.

The group which a first-rate rifle will make is, up to 1,100 yards at all events, not far from proportionate to the distance of the target under equal conditions. A series of shots may often be placed within an angle of 3′, *i.e.* 3 inches at 100 yards, and not infrequently within the same measurement, *i.e.* 30 inches, at 1,000 yards, although there is a distinct tendency for the shots which deviate from the general line of the group to wander further and further away from it. One curious phenomenon which may be mentioned here is that if a series of shots be fired through several screens of thin paper interposed in the line of the trajectory, it will be found that hardly any one shot will maintain on all the screens its position relative to the others, even in the calmest weather. In the central part of the group, which represents the normal shooting, the shot which is highest in the first screen will often not be so in subsequent ones, and so on. The shots really change places in a way not to be accounted for by any atmospheric movement. When we come to those more wandering shots which, edging away in any direction from the centre of the group, so often spoil a series of bull's-eyes, both at short range and at long, they seem to have some eccentricity of flight which carries them out from the group, and they seem to wander further from it at the longer ranges. Whether these abnormal shots are produced by some irregularity of ignition of the powder, or by some casual deposit of the fouling in the barrel, causing unusual friction, or, it may be, setting up some odd movement of the muzzle at the moment of firing, is not clear; but while the general grouping of the central shots with smokeless powder in modern military rifles is closer than it was with the best of the old military breech-loaders firing black powder, the outer shots seem often to fly more widely and more wildly.

To ascertain the regularity of different loads, as well as the actual velocity which they give to the bullet, many devices have been and are used. It is not possible here to describe them at any length. The earliest machine for the purpose, that used, for instance, by Robins, Count Rumford, and Hutton, was a pendulum; the measurement of its movement, on receiving the impact of the shot, enables the velocity to be calculated, the weights both of the pendulum and of the bullet being known. This instrument in its old form was not very satisfactory, the relation of the point of impact to the centre of gravity having to be taken into account. The writer has one similar to that used by Mr. Metford in his experiments, which is hung by four wires in front and the same number behind, a length of some 2 feet

6 inches being given to the pendulum bob, and the wires spread laterally at the points of suspension, so that it can only swing in one direction. The attachment of the wires to the pendulum and to the sockets from which it is hung is by bearings having knife-edges. This reduces friction and makes the movement of the pendulum independent of the precise point at which the face of it is struck. To get true results with a pendulum it is necessary that the whole of the fragments of the shot should be caught, and this is effected by fitting a steel shield 8 inches in diameter in the head of the pendulum and placing in front of it a wooden block some 2 inches thick. The bullets pass through this and break up on the steel shield, and their fragments cannot escape. The weight of the wooden block, which has to be renewed after a few score of shots, is taken into account, and the weight of the pendulum is maintained by placing upon a little shelf attached to it a number of bullets of the kind about to be used, and removing one for each one that is fired into the pendulum. A sliding index pushed back by an adjustable screw at the tail of the pendulum gives the measurement of the horizontal swing from which the velocity is calculated.

It is, of course, really the height to which the pendulum is raised that forms the basis of the calculation. The length of suspension, ascertained precisely from the time of swing, is about 100 inches, and the pendulum weighs when ready for firing about 140 lb. Its movement is easily read to $\frac{1}{1000}$ of an inch, which with the ·256 bullet of 156 grains represents about 1 foot of velocity. The disadvantage of the pendulum is that the weight of the bullet requires to be known with considerable accuracy. Chronographs are therefore more commonly used, which depend upon breaking and making an electric circuit. In the Boulengé chronograph used by Bashforth in his experiments, and improved by Major Holden, the passage of the bullet through two wire screens placed at some little distance apart first releases a steel bar suspended by one end by magnetic attraction; the breakage of the circuit at the second screen releases another bar, which falls on a trigger, causing a knife to make a mark on the falling bar first released. The length of the bar representing the amount of its fall is then measured by a suitable scale giving the equivalent in velocity of the time taken in the passage between the screens.

Another class of chronograph, such as that invented by Professor Jervis Smith, depends upon the movement of a cylinder or a piece of smoked glass, on which a tuning-fork marks a scale of time, the instants of breakage of the circuit at the screens being marked against the scale. Dr. Crehore and Dr. Squier seem to have hit on a new and successful method of obtaining a record of minute intervals of time by photography. The sensitive plate moving at a known velocity, a ray of light is admitted on the first breakage of the current, and extinguished on the second. This is effected by passing the ray through prisms, and then through a liquid which, under the influence of an electric current, polarises the field. The method is fully described in 'Arms and Explosives,' September 1895.

The screens used with the Boulengé chronograph are commonly placed 180 feet apart. Sometimes a wire close to the muzzle of the rifle is substituted for the first screen. The mean velocity of the shot between the screens is usually taken as being equivalent (as it very nearly is) to the velocity at a point midway between them.

A very old means of ascertaining velocity was by rotating two discs fixed at a short distance apart upon a rod, and measuring the amount of the rotation during its passage between the first disc and the second. This was unsatisfactory, as it postulated a very accurate knowledge of the direction of the bullet's flight, and, though he has seen it described in books, the writer has never heard of it being actually used.

The advantage which electric chronographs have over the pendulum is that the weight of the bullet does not require to be accurately known, since the time of flight over a given distance is measured. They are equally available for small arms or for cannon. They are, however, more costly and less simple, and perhaps not so well adapted for very occasional use.

CHAPTER XIII

ACCESSORIES—SIGHT PROTECTORS—PAINTS—VERNIERS AND THEIR USE—VENTOMETERS—ORTHOPTICS—THE BLOW-TUBE—GLASSES AND TELESCOPES—SCORE-BOOKS—THE AIM CORRECTOR—CARE OF RIFLE—CLEANING—RUST—ITS CAUSES AND PREVENTION—CARE OF STOCK AND LOCK—PULL-OFF—MISS-FIRES

The incumbrances of the careful shooter are increased by his having to use constantly two sight protectors, one to cover the back sight, and the other the fore sight. The latter is usually a piece of tubing which fits over the muzzle of the rifle, and has a high recess formed in it, which encases the fore sight. Sometimes it is secured by a bayonet catch, and the box covering the sight is closed by a little lid. Sight protectors of this kind usually have the end completely covered so that dirt and sand are prevented from entering the muzzle. It is not many years ago that sight protectors were occasionally made with a piece of brass tubing to fit into the bore at the muzzle, in order, presumably, to give them a firmer hold, but this abomination, which was very likely to injure the internal surface of the barrel, seems now to have been generally discontinued. The fore sight protector exists mainly to secure the sight against damage from a fall or a blow. We have already spoken of other methods of protecting the sights, and it may be hoped that before long the detached protector may become, so far as the English military weapon is concerned, a thing of the past. The function of the back sight protector, as used by the marksman, is chiefly to prevent any colouring matter put on the sight from being rubbed off; it is not recognised as suitable for military service. The arrangement should be such that the back sight may be covered when the slide is set at any desired elevation, without being necessarily lowered to the bottom.

There are several accessories which the target shooter commonly uses, and which undoubtedly have value as enabling better work to be got out of the rifle under the conditions of target practice. We have spoken of the painting of the sights. A little box, with black and white paint and brushes, or, if not white paint, a pencil that will make a fine white line, are an indispensable part of the equipment of the man who goes forth to make bull's-eyes with a Service rifle. We have mentioned the way in which the fore sight may be painted, and the method of putting a line upon the back sight to give allowance for the wind. It is well not to introduce greater complication in these matters than can be helped. The line or lines on the back sight may be broad, or they may be narrow, but the shooter should endeavour so to arrange his methods that he does not have to delay the firing even for a few seconds, to put on fresh lines after he has begun to shoot.

One other appliance is almost indispensable for the accurate adjustment of elevation, and that is the vernier. This old but simple invention owes its name to Peter Vernier, a Frenchman, who invented it 300 years ago. It is most commonly seen attached to the scale of barometers to give accuracy in reading the height of the mercury column. It is very generally used in all instruments in which it is desired to obtain exact measurements, and is at the present day very well known. It consists of a large and visible scale so arranged that very fine measurements can be made on it by the movement of a sliding piece, carried usually on a screw. The principle of the vernier is that a short scale is cut on the sliding piece, which is spaced at wider or narrower intervals than the fixed part, a proportion being maintained between the two which enables finer divisions than the spaces marked to be noted by adjustment of the two differing scales. Let us, for example, take (fig. 76) some part of the scale of degrees and minutes running up to 1°. Assuming this to be engraved upon the fixed part of the vernier, the radius of the circle on which the degrees and minutes are measured will be so small that a division into single minutes would not be clear to the unassisted eye. The sliding part may have engraved on it, for instance, a short scale, of which the total length is equal to 20′. Whereas the fixed scale in the same space has divisions at 5′, 10′, 15′, and 20′, on the sliding scale the space of 20′ is divided into five smaller spaces of 4′ each, and has divisions at 4′, 8′, 12′, 16′, and 20′. These divisions are numbered 1, 2, 3, 4, 5. The diagram shows the proportion of the two parts of the scale when set alongside each other. Now let us place the zero of the sliding scale against the line denoting 30′ on the vernier (fig. 76). If we wanted the vernier to read 35′ we should obviously move the screw until the zero of the sliding part came opposite to the line representing 35′, but if we want 31′, we have only to move the screw one-fifth of that distance, which we measure by noticing that the line on the sliding part, which has the figure 1 against it, is brought into coincidence with the first line above the 30′ on the fixed part, that is, 35′. When this has been done it is clear that the sliding part has been moved one-fifth of the distance between 30′ and 35′, and accordingly the vernier is correctly set for 31′. If we want one minute more elevation, 32′, we have only to move the sliding part until the figure 2 is opposite the next line, that which denotes 40′ on the fixed scale, as shown in the figure. We thus have a system of very fine division of the scale, which is yet quite easily read. This system is applied to the sights of the Match rifle (Plate XXXVII, fig. 1), which are cut in degrees and minutes of a circle whose radius is the distance between the fore sight and the back sight. On the ordinary detachable vernier, for use with the Service rifle, the divisions are usually numbered in a consecutive series up to more than 100, each representing the one hundred and fiftieth part of an inch, this being closely equivalent to the value of 1′ on a circle whose radius corresponds with the distance between the fore sight and back sight of the Lee-Metford rifle. Fig. 77 shows the usual form of the detachable vernier; another variety of it is given in fig. 78. In the latter, that

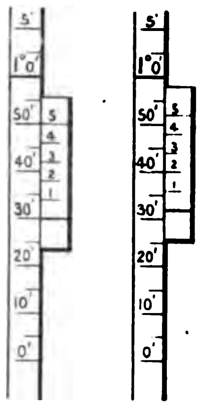


FIG. 76

part of the sliding-piece on which the scale is engraved is made moveable, and can be adjusted within certain limits, and then held fast by a binding screw. This allows the reading to be made to correspond with that of another vernier used on another rifle, and so the elevations of different rifles fired by different men can, for purposes of team shooting, be brought together. The normal reading of the vernier for the ·303 rifle should properly be such as will give 30′ for the elevation at 500 yards; the elevations for the longer distances will then correspond with those given in the table of angles for the Service charge.

FIG. 77

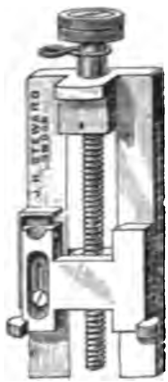


FIG. 78

In using the detached vernier with the back sight of the military rifle, the sliding piece is lowered rather below the required elevation, and the vernier is held carefully against the sight on the side of it towards the muzzle, the horns on each side of the vernier projecting on each side of the uprights of the sight, and so coming under the ends of the bar. The projecting piece at the top of the vernier is in contact with the top of the back sight and is pressed down upon it. The sliding bar of the sight is then pushed down until it rests upon the movable part of the vernier, and the vernier is held in this position against the sight while the screw is turned so far as will bring the moving part, and with it the bar of the sight, to the proper elevation. If now the vernier be simply pulled away from the sight, there is danger that the bar may be shifted, so that it is best to unscrew the vernier a turn or so in order to loosen its grip of the sight; it can then be removed without difficulty. It is quite easy thus in a very few seconds to make with certainty an alteration in the elevation of a minute, or even half a minute, of angle, and this is a great advantage, since the mere moving of the bar with finger and thumb is necessarily rather a rough-and-ready affair, and to move it correctly a very small distance a matter of great difficulty. In using the vernier it is important to be very careful how far correction is applied for the defect in elevation of any single shot. If the first shot strikes, say, 12 inches too low at 600 yards, and there is no apparent reason why the elevation should be 2′ (=1 foot at 600 yards) below the normal, the probability is that the shot is one of those which would be in the bottom of a group of shots fired at the same elevation, and it will be as well not to give the full correction at once. It will probably be found that raising the sight 1′ will bring the next shot near enough to the proper elevation; and if that should still tend to be low, then the sight can be raised another minute. If the bullet could be depended upon to fly absolutely true, there would be no difficulty in correcting the aim after any shot, but judgment is needed to know how far to argue from the particular to the general—from one or two shots, which may be slightly abnormal, to the rest of a series. It thus becomes important to note the precise spot struck every time, with the view of correcting any tendency of the shots to group themselves in some particular direction away from the bull's-eye. It requires a good deal of care to make a pencil dot on exactly the right spot on the diagram in the score-book, and there are many men who do not know how incorrect their spotting is. There is an almost inevitable tendency, if one is not very careful to check it, to represent shots as being nearer the centre of the bull's-eye than they really are, or as very nearly touching the line of the bull's-eye, or inner, when they are really well outside it. The tendency to mark shots as being almost exactly on the horizontal line across the target is very distinct in many score-books. The writer remembers on a certain long range used by a club, a little wooden target, which used to be stuck up at the firing point, and on which the position of the last shot used to be marked with a drawing pin by the sergeant in charge of the range, to show the firer exactly where the shot had hit. He had a good pair of glasses, and took much trouble, and he was an experienced man; but it was curious to see how, in the course of some years, the little holes made by the drawing-pins formed a pattern almost like a cross on the paint of the wooden dummy, because somehow the shots were almost always on the horizontal line, or on the vertical one, which meet at the centre of the target, and had an invincible aptitude, as it seemed, to crowd close into the centre of the bull's-eye or against the circles surrounding it. Nobody ever made a bull's-eye close to the edge, a very bad inner, or a very bad magpie upon that target. The well-known optical illusion, which makes it so difficult to divide off-hand horizontally a square drawn on a piece of paper, is answerable for a good deal of the error in spotting. Sir Henry Halford, who always used a telescope to spot his shots, used to consider that he could record the position of the shot at 1,000 yards correctly to within two inches upon his diagrams, but there are very few men who would not constantly make a larger error. The mere writing of a figure on the approximate position of the shot on the diagram gives a very vague and unsatisfactory record in comparing the performances of two rifles, or of different charges in the same rifle, or of the varying effects of wind, &c. It is not possible to obtain any correct result unless a very accurate diagram is kept, and it often happens that too large or too small a correction is made for wind allowance or elevation from want of care in observing the spot struck by the previous shot.

For the Match rifle, as has already been shown, it is not necessary to use a detached vernier, since a vernier scale forms part of the back sight. The divisions on the vernier are very easily read, because the sights are about 45 inches apart owing to the special position of the back sight on the heel of the butt, and consequently the scale of degrees and minutes is proportionately enlarged, as compared with that for the military rifle. The principles which guide the correction or alteration of elevation in the course of shooting with the Match rifle are just the same as those for the military rifle, except that owing to the longer range at which it is generally used, even more experience and judgment is required in applying them.

There are small instruments commonly known as ventometers (fig. 79) (a misleading name, as they do not in any sense measure the wind, but only assist in applying a correction for it), which are used to mark the wind line accurately on the straight bar. These are of various patterns, but all depend upon the same principle. They are placed transversely to the back sight, and bearing upon the outside of the uprights. By moving a screw, a small, sliding square is brought either to the centre of the bar, or to any other point, and enables a line to be marked in precisely the right place, the distance being measured by a little scale, similar to that of the vernier, and giving similar divisions of $\frac{1}{150}$ of an inch. These are very useful little instruments, and are used by a large

FIG. 79

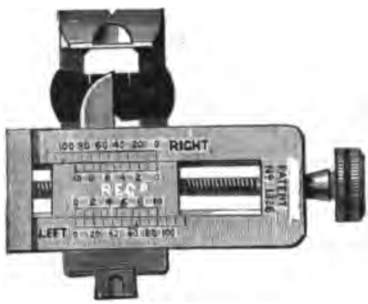


FIG. 80

number of shooting men. They are sometimes fitted to the elevation vernier itself, as in fig. 80.

We have spoken of the orthoptic or peephole sight, used with the Match rifle, and have described the advantages it gives as compared with the ordinary back sight. These advantages can in a measure be applied to the ordinary military or sporting sights by using an orthoptic disc as a kind of spectacle, in substitution for a lens. Such a disc is made of some opaque material, with a hole or holes of a suitable size in it, and is arranged in a spectacle frame, or otherwise, so that it can be adjusted to exactly the right position in front of the eye, for aim to be taken through it. It will be found that in aiming with the ordinary sights seen through such an aperture, the eye, especially if it be beginning to suffer a little from long sight, or presbyopy, but does not yet require glasses, will see the back sight and the line or lines upon the bar almost without a blur, and will aim, or appear to aim, with great correctness. This is because aim is taken only with a small pencil of rays coming through the centre of the lens of the eye. The orthoptic in this form is used by many prominent target shots, and is considered to be of the greatest possible assistance. It certainly does help in definition. It has, however, one disadvantage, that it largely reduces the amount of light which comes to the eye, if it be so small as to give very clear definition of the back sight. There is a further objection to it, that it does not at all tend to quickness of aim. It is considered, and with much apparent reason, that the orthoptic is a complication which could but very exceptionally be used in the field under the ordinary conditions of war. Certainly one would not think of using it for deer-stalking. A curious fact, which suggests that the advantage of using the orthoptic spectacle is by no means all that it is supposed to be is the following. At the Bisley meeting of 1900, the regulations under which the competition for the St. George's prize took place were modified so as to forbid the use of orthoptics. This competition is in two stages, and was shot for at 500 and 600 yards, the one hundred highest scorers in this part of the competition afterwards firing at 800 yards, and the event being decided by the highest aggregate score in the two stages. The first prize was won by Armourer-Sergeant Fulton, an old Queen's Prize winner, with the very fine score of 113 points, out of a possible 120, at the three ranges. Now it is a curious fact that Mr. Fulton is one of those who habitually use the orthoptic, and might be expected to be considerably handicapped in a competition in which it was not allowed, yet he shot in quite as good form without it as with it. This does not look as if in the majority of cases the advantage given by the orthoptic were so great as it is commonly supposed to be.

A great practical objection to the use of the orthoptic is that it narrows the field of vision of the aiming eye to the small view which can be obtained through the aperture. This matters comparatively little in target shooting, but it is decidedly a drawback where it is necessary to be keeping a general look-out while shooting. With the left eye closed in order to aim, and the right eye almost entirely blocked by an opaque disc, the shooter is for the moment at a disadvantage. The writer has found that an orthoptic disc of less than ½-inch diameter is all that is required to clear the view of the sights in aiming, and that it hardly does more to obscure the view than does the ring of the Lyman sight used on the sporting rifle. It is certainly of importance that one should

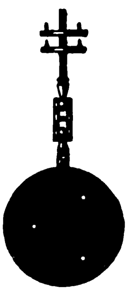


FIG. 81

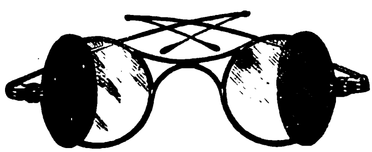


FIG. 82

FIG. 83

not accustom the eye to feel in a difficulty about aiming unless the whole field of vision is narrowed down to quite unpractical dimensions. In the evening light at the Bisley ranges, or others so situated that late in the day the sun shines nearly behind the target and makes shooting difficult, there is some advantage in using an orthoptic, since it shuts out much of the dazzling light from the eye. Fig. 81 shows a disc with three apertures of different sizes in it, any of which can be brought to the most convenient place for aiming, the whole disc being mounted on a ball-and-socket joint which gives the most complete control of its position. We also illustrate (fig. 82) a similar disc fitted to a pair of spectacles. A point which should be noticed in using the orthoptic is, that it is well not to use a smaller aperture than will serve the purpose of clearing the view of the back sight under the particular circumstances of light at the moment. An excellent form of orthoptic, which makes it easy to attain this end, is that known as the iris orthoptic, the aperture of which can in an instant be altered in size. This is illustrated in fig. 83. The aim must always be carefully taken through the centre of the aperture, since the rays of light which enter the eye close to the edges of it seem to be distorted, but the eye quickly acquires the habit of aiming through the centre. On the whole the orthoptic is a complication which should not be necessary for young eyes, and which should be eschewed unless really found to give a distinct advantage.

One complication for match shooting which used to be nothing less than a nuisance has been done away with owing to the introduction of smokeless powder. It was found that the fouling of black powder in the barrel was, if not checked, liable to be fatal to accuracy, especially in hot and dry weather. The invention of a little tube, one end of which was fitted to the cartridge chamber, and the other breathed into by the mouth, largely solved this difficulty, as by its means the fouling could be sufficiently moistened to offer but little obstruction, and that very uniform in degree. It led, however, to the absurdity that a great part of the intervals between the shots in target work was devoted to blowing and blowing, as it appeared, into the breech end of the barrel, an occupation very far from dignified. It looked, in fact, to the uninitiated as if the shooter were sucking at his rifle, as a baby sucks a bottle. Smokeless powder, although its fouling undoubtedly does cause difficulties, yet does not seem to leave a residue which can be usefully dealt with in this way. There is a tendency to retain the use of the breathing tube, but, so far as the writer knows, it is under present conditions quite useless. There was similarly a tendency, which long survived into breech-loading days, to suck or moisten the bullet before the cartridge was placed in the chamber to be fired. This likewise seems to have been a vain superstition, and probably was a survival from the biting of the muzzle-loading cartridge.

Whether in the field or at the target, an indispensable accessory for shooting is a good pair of glasses. In the former case they may often help to distinguish or define the object to be shot at, and in the latter case they are of use in exactly observing the result of the shot. The Bisley system of marking with penetrable targets hung upon balanced frames, which was adopted as a result of Swiss experience, requires, at all events at any range beyond 200 yards, that glasses should be used to see exactly the spot which has been struck as indicated by the spotting disc. If the young shooter, whether soldier or civilian, is to be taught, as he should be, to endeavour to hit, not merely the bull's-eye, but the centre of it, he should also be taught to observe for himself the position of his shots, and not to depend on the inaccurate description of some supervising sergeant, that the shot is 'high right' or 'low left,' &c. The extreme utility of glasses and telescopes, as shown in the South African war, no doubt extends in some degree beyond what is practicable in a European climate; but with modern arms, both in war and sport, the difficulty of defining the object is often quite as great as that of hitting it when it has been defined. There have been instances in South Africa in which the range has been found by a good marksman shooting to strike dry patches of soil, and having a comrade close by him who might also have been shooting, but was better employed watching the bullets strike, and so enabling the elevation to be corrected until the proper allowance was known, and communicated to the rest of the men firing. The observation of the effect of fire is a most important military accomplishment, and one for which good glasses are indispensable.

At the longer ranges at Bisley it is at times difficult to be sure of the position of the spotting disc with a field-glass, and even at the shorter the shooting cannot be accurately spotted without one. While telescopes and binoculars of the very best make will always be expensive things, a few shillings will now buy glasses which will give an immense amount of assistance to the eye. On a day of light moving air currents, when the flags are contradictory and the sun is shining, the best guide to the wind is the mirage; this can be better seen, especially when it is dying out as clouds come over, with a telescope of high power than with an ordinary glass. At all times the mirage is best seen when magnified. For watching the precise direction and movements of flags at some distance away, the glass comes in very usefully.

It is a very proper rule at Bisley which forbids the firing point being cumbered with stands for holding the telescopes or glasses of those firing in individual competitions. When practising at a target, however, it is a great convenience, if using a telescope, to have some support for it, as a couple of iron forks, with a straight stem, some 15 or 18 inches long, and a semi-circular fork at the top. The lower end of the stem being pointed, they are usually pushed into the ground, and the telescope, lying upon them, is directed at the target. Then after each shot in the lying down position the shooter has merely to place his eye to the telescope to see the position of the shot, and is not troubled with having to take it up and hold it while looking. In team matches under Bisley rules there is no objection to the use of telescopes fixed on stands, and during such matches as that for the Elcho Shield, they may be seen in some numbers and of all sizes at the firing point, with a careful observer in charge of each, not only to spot the position of the hits, but to watch the shots, especially the first one fired by each man at each distance, in hopes of seeing, if it should miss the target, where it strikes.

Another accessory for target shooting, which is quite as important as any, is the score book. It has already been pointed out how useful it is in keeping records for any purpose, to make a correct diagram of each group of shots fired. But the diagram will be of very little use unless it be accompanied by such particulars as will enable it subsequently to be used for purposes of comparison. It is important, for instance, to note the name of the competition, if it be a competition that is fired; and the score, as well as the date and the range on which the shooting takes place. If the shooter has more than one rifle, it is advisable to give the number of the rifle, or some description which will show what rifle was used on the particular occasion. Careful note should be made of the direction of the wind, and its approximate force, as well as of the degree of allowance (preferably in minutes) made for it at every shot. The kind of weather, and the approximate temperature should always be noted ; and the elevation used on the vernier for each shot should also be recorded. The batch of ammunition used should be noted. It will then be seen, by comparison of the records of shooting under different circumstances, what are the variations for any range due to the changes of conditions, and this will give confidence in firing the first shots on subsequent occasions, and will materially assist in starting the scores with the necessary bull's-eye. Another very practical advantage of keeping a careful record of the shots is that should any question arise as to the official scoring in a competition, or the total of the score, the competitor does not have to depend on memory alone for the facts of his shooting.

In Match rifle shooting at long ranges the keeping of complete records is far more necessary than at short. When it is desired to compare the results obtained from different rifles, or from variations in loading, or to make any kind of experiment, it is of the greatest utility not only to keep a record of them at the time, but to have careful records of all the shooting with which one may wish to make comparison for these experimental purposes. The particulars should always be noted down very completely. The reading of the barometer and thermometer, and other conditions of weather, should be accurately observed. It is very unsatisfactory, for instance, in looking back to see whether one's diagram of to-day at 1,000 yards is as good as any one has ever made at that distance under the same conditions, to find a better diagram recorded, but without sufficient detail added to show whether it was made with the same rifle, or, it may be, at 1,000 yards, and not at 900. Great success may be attained as a shot by a careful man who does not keep a score-book, but he deprives himself of one of the elements which give appreciable assistance in the long run.

Fig. 84 shows a device known as the aim corrector, which is ingenious and very useful in checking the errors of the young shot during instruction. Its chief feature is a small piece of darkened glass so fitted that it can be clipped on to the barrel behind the back sight. It is fixed at an angle of 45°, so that the instructor, standing at the side of the rifle and looking into it at right angles to the line of fire, sees a dark but distinct picture of the alignment of the sights, and can tell with the greatest nicety whether at the moment of pulling the trigger they are properly directed upon the mark. The firer's aim is but little interfered with, for he sees the sights and the target perfectly but for the diminution in the amount of light caused by the tinted glass. This is a most useful appliance, and it can be strongly recommended for correcting the errors of an unsuccessful beginner, or practically teaching the alignment of the sights, whether during instruction in aiming or during actual firing. It is habitually used in Switzerland during the instruction and first practices of recruits.

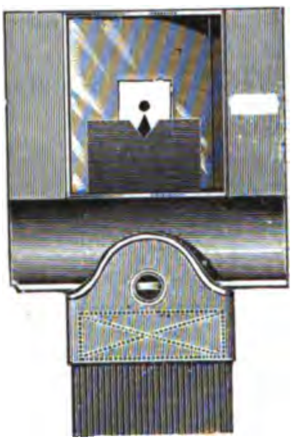


FIG. 84

We have left to the last a chief accessory used by almost all marksmen, the shooting-bag, or shooting-case, which holds score-book, glasses, vernier, &c., and is carried in the hand or slung over the shoulder. Of this little need be said; it should be as small and light as possible, and it should be such as will fairly protect its contents from wet when in use. There was a time when the Match rifle shot carried much luggage—a bag full of cartridges and sights, as well as a tin waterpot and cleaning-rods; now the accessories for shooting with the military rifle are usually as many and as bulky as those for the Match rifle.

Chapman, in speaking in 1848 on the use of the rifle from the American point of view, alludes to the advantages which American troops have as against European in the habitual use of the rifle in civil life, and says: 'A man accustomed to carry a rifle with as much care as an Old Countryman does a watch; educated, perhaps born, in the woods, accustomed to hang his life upon the "certainty of a sure shot," is a tremendous overmatch for another, who knows his weapon only on drill, never saw a clump of trees larger than those in Hyde Park, and who, as a marksman, is likely to hit neither the tree nor the man behind it.' Herein is much food for reflection. Who can imagine the practical backwoodsman or hunter treating his beloved rifle with the roughness often seen at drill, the butt of the rifle brought to the ground heavily, and the weapon itself treated as if the highest compliment which could be paid to it were to see how far it might be possible to carry rough usage? If rifles are to be treated merely as lumps of wood and iron, more than half the advantage of possessing arms of precision is gratuitously given away by those who use them. The endurance of our military rifle is very great, and perhaps this fact has tended to encourage its being treated with scant consideration; yet, if we are to regard essentials in the first place, the care of his arms should, in a soldier's education, rank before the care of his accoutrements and the precise folding of his great-coat.

It has always been a matter as important as it is difficult to prevent guns and rifles from suffering from rust. In muzzle-loading days much trouble used to be expended, and very properly, in washing out the barrels after firing. Since breech-loaders have been in use, the difficulty of inspecting the bore in order to see what its condition may be has very much diminished. Most modern breech actions, although that of the Martini-Henry was an unfortunate exception to the rule, allow the eye to be brought into line with the centre of the barrel when the breech is open, so that the interior of the bore can be seen for its whole length, and a cleaning-rod passed through from the breech end. This renders it simple enough to clean the barrel; and any wear of the grooving from the rubbing of the cleaning-rod against it takes place at the breech end of the barrel, and not at the muzzle; for if there is one part of the barrel more than another in which it is important that the grooving should not be worn, and that there should be no irregularity of shape, it is the last few inches near the muzzle. It was to guard against any such wear that the 'false muzzle' was fitted to the muzzle-loading Match rifle in old days. This was a metal cap, grooved so as to prolong the rifling which, when it was in place, was continuous with that of the barrel, and its mouth was tapered so as to make a guide for the wadding and bullet. The writer believes it to have been an American invention. It was very easy to forget to remove the false muzzle before firing; if left on, it was carried some distance by the bullet and spoilt the shot. It was therefore usual to attach it by a string to a button on the firer's coat.

On the surface of the bore of a new rifle it may perhaps be possible to discern the marks of the tool with which the rifling has been cut, but these are soon obliterated with wear; but it used to be considered with the old Metford Match rifle that the barrel required a good many shots through it before it was in perfect shooting condition. When a barrel has had the grooving properly cut, it requires no polishing with emery, or any other cutting powder, the chief effect of which is, while giving a superficial polish, to tend to destroy the accurate surfacing of the different parts of the bore, upon which the excellence of the shooting most depends. The old Match rifle bullet of lead, which bore upon the rifling only through its thin petticoat of paper, took several hundred shots to complete the polishing of the surface of the bore; but it performed this process very thoroughly, and in the best possible way, since every bullet without fail rubbed the surface precisely in the direction of the spiral. The rifle with which Major Gibbs made his remarkable score of 48 bull's-eyes out of 50 shots at 1,000 yards at Wistow was an old one belonging to Major Young, and had had some 20,000 shots fired out of it. When the barrel is polished by hand, or even by machinery, it is not easy to make the plug carrying the polishing powder work infallibly in the direction of the grooving. With modern bullets, covered with a hard metal envelope, the polishing of the barrel is very rapidly effected. Normally speaking, the better polished a barrel is, the easier it is to keep it from rusting. When once even the most delicate cloud of rust has settled upon it, the tendency is for the rust to recur, and it is very difficult to prevent it doing so. A rifle or gun used with black powder was very liable to rust, if not well looked after, but it could be very effectually cleaned with a little trouble. The phenomenon which has puzzled so many people, of the pitting with rust starting near the breech end, in front of the chamber, and being far greater there than towards the muzzle, seems to be connected with the bad effects of the combustion of the fulminate in the cap. Some of the smokeless powders used in shot guns seem to have an almost neutral effect as regards rust, and the barrel requires much less cleaning to keep its surface perfect than it did with black powder. In modern rifles, however, and especially in the military rifles of small bore, the tendency to rust is very deplorable, and almost inevitable. It does not quickly arrive at the stage of a distinct honeycomb, since the scrubbing of the bullet upon the bore tends to keep the surface even, but there are very few barrels which have been in use for any length of time which do not show upon close inspection a loss of polish, if not an actual rusty patch at some point or another in the bore. It is an undoubted fact that the residuum from some of the smokeless rifle powders has a most marked rusting effect upon the steel. There are others which seem to tend less to rust, but considering the small amount of fouling actually deposited on the bore, the difficulty of removing it is really extreme. In the days before smokeless powders it would have been considered an almost fatally strong measure to clean the bore by dragging to and fro through it a tightly fitting piece of wire gauze, which scrubs the surface very severely. With the ·303 this is one of the commonplaces of cleaning; nay, it is part of the regulation method. It must not be supposed that the deposit from the explosive is the only factor in the case which demands such strong measures. The observant man will have noticed that if he fires with copper-clad bullets, or with the ordinary bullet with cupro-nickel covering, a deposit of the colour of the particular metal is often left in the bore upon the lands, and can clearly be seen on them at the muzzle. This means nothing else than that an actual deposit of metal has been left from the coating of the bullet in its passage up the bore. Occasionally, even with the ·303, small chips or flakes of the metal envelope will imbed themselves in the surface of the barrel, and cause great trouble. They are very difficult to remove; while they are present the shooting is not accurate, and in the removal of them the smoothness of the bore may easily be ruined. But whether it be merely a film of metal or something more that is deposited, it undoubtedly becomes a potent factor in the creation of rust, very probably in part because galvanic action is set up between the deposit and the surface of the steel. It is almost heartrending to find, after great pains have been taken to clean a rifle properly, that the next morning a white patch of calico passed through the bore comes out all red with rust. Unfortunately this is no uncommon experience. Sometimes the red colour of the rust is not apparent. It has often been the writer's experience with the Mannlicher, that scrub and scrub as one may, there remains a black deposit which refuses to be removed entirely from the barrel, and is more apparent and quite as persistent the next morning as it was during the cleaning on the previous day. There seems to be no sovereign remedy for this state of things. The cordite oil, issued to the Army, and containing a proportion of caustic potash as a preventive of rust, is probably not more effective in preventing it or in cleansing the barrel than an ordinary mineral oil.

The restoration of polish to the barrel by the use of fine polishing powder is a process which becomes impossible after the rust has really established a hold, and even when it is not too late requires the greatest possible care. The writer remembers years ago curing a Snider rifle of incipient rust, without leaving any ill effects, by firing through it first bullets coated with extremely fine emery flour made into a paste with vaseline, and afterwards bullets coated with a similar paste, very fine crocus powder being substituted for emery. It was a drastic remedy, and one suited only to such a rough-and-ready weapon as the Snider was. No polishing powder but the very finest should ever be used in the barrel of a modern rifle. Any little roughness of surface left by the tool in the barrels of Match rifles could in the old days be polished out with a long series of shots, by using bullets with a paper patch rubbed with oil and crocus. The expansion of the bullet brought the polishing powder into close contact with the surface, and the line of the polishing was bound to follow that of the spiral of the rifle. The method of forcing a hard-coated bullet into the grooving is not well suited to this process. If polishing has to be done, the very fine crocus or other powder employed should be mixed with oil and applied upon a pad of tow or calico, which has already been passed through the rifle, and fits it very tightly. The rifle must be firmly held in a padded vice, and the greatest care taken that the spiral of the rifle is accurately followed in pushing the rod to and fro. Nothing but damage is done if the rod is pushed straight up and down the barrel, as in that case it is only the tops of the lands which are polished, while their edges are irregularly rounded off. The amateur is not recommended to undertake such a polishing operation unless he has already a good deal of experience of workshop processes of a similar kind. It is perhaps not superfluous to add that the cleaning-rod used for such operations must be a very strong one, and that it must have such a handle as will allow considerable force to be applied to it.

As with many other processes, 'elbow-grease' is probably the chief and most important ingredient in any recipe for cleaning and preserving fire-arms. Pure olive oil, if it were possible to get it in this country, seems to be the least harmful of vegetable oils, but there is nothing better than Rangoon oil or vaseline. The vaseline does not require to be refined to any great extent. That of the ordinary yellow colour is perfectly good, and the variety known as veterinary vaseline, which can be bought comparatively cheaply in tins of 1 lb. or more, seems to answer every purpose. On the other hand, the writer has on one occasion seen trouble caused by the use of a variety of vaseline which had been specially refined so as to be of a transparent white colour. Possibly there were remains of some acid in it.

So far as the tendency to rust depends upon the acid condition of the residue of the fouling, it can be to a great extent neutralised by the use of some such alkaline preparation as boiling water containing caustic soda. Boiling water alone will bring a surprising amount of dirt out of a rifle barrel. The rifle should be held muzzle downwards over a bucket, and a small bent funnel inserted in the breech, into which the boiling water is poured from a kettle. Care must be taken not to wet any of the breech mechanism. It is surprising how much dirt may still remain in the barrel even after a large kettleful of hot water has been passed through it, carrying with it a very noticeable amount of fouling.

A counsel of perfection, for it is impossible to follow it under sporting or service conditions, is to clean the rifle immediately after firing, if possible while still hot from shooting. The difficulty of removing the fouling, especially that of cordite, from the surface of the bore after the lapse of two or three hours, must be experienced to be understood. The double pull-through of wire gauze is a very severe remedy, but almost indispensable under such circumstances. Clean and dry pieces of rag, flannelette, swansdown calico, or soft tow should be used for ordinary cleaning, and should be well worked up and down the barrel, which must be wiped dry after each application of oil. To leave foul oil in a barrel is to make damage a certainty. Rust should be regarded as an infection likely to be conveyed by the use of dirty brushes, oil, or cleaning material. For cleaning at home there is no such convenient arrangement as to have a bench, fitted with a vice, with cork jaws. The rifle can then be firmly held, while both hands are free to use the cleaning-rod. A strong one of steel, with a wooden handle, is far the most satisfactory implement. A cleaning-rod covered with wood is not objectionable, but unless kept very carefully clean is liable to pick up grit, which, becoming imbedded in the wood, has a more destructive effect upon the bore than the scrub of the steel rod against it. The writer does not recommend a bristle or wire brush except for very rough temporary cleaning, when it is sometimes convenient. Mr. Tippins advises the use of a small brush on the end of the cleaning-rod as a good means of holding the rag which actually does the work of cleaning the barrel, and there is much to be said for this device. Whether it be a brush or anything else which is constantly passed through the barrel, it is inevitable that it should become a dangerous element by itself depositing impurities upon the bore. A brush of brass wire, for instance, will sometimes be a useful preparation for a thorough cleaning, but for this reason must not be depended upon except as a preliminary.

In the days of black powder there was a marked difference in the amount of cleaning required by such a rifle as the Martini-Henry, which had angles in which the fouling was deposited, and the Metford rifling, with the segmental grooving, the latter having no corners to catch the dirt. Something of the same distinction remains in the ·303, between the Lee-Metford and the Lee-Enfield. It is unquestionable that the recesses which are at the corners of the grooves of the latter are far more difficult to clean thoroughly than any part of the Metford grooving; and that this is the fact is clear, not only from the greater difficulty of removing the fouling, but from the greater tendency which there is for rust to form in the angles of the grooves. There seems also to be a much greater probability of flakes of the coating of the bullet being caught and remaining imbedded in the surface of the bore with the Enfield cut than with the Metford. It is highly probable that a five-grooved rifling, with the grooves of about the same width as those of the Lee-Enfield, but cut segmentally so as to have no internal angles, would diminish some of these difficulties. It may almost be taken as an axiom that the smaller the bore the harder it is to keep in order, partly because of the difficulty of inspection (its surface cannot so well be seen from either end), and partly because the whole bulk of the pad, or other cleaning appliance, is smaller, and has less elasticity. A more important reason is that, except in toy or gallery rifles, the pressures and other effects of the explosion, as well as the use of smokeless powder, very much complicate the whole problem as regards rifles of small calibre. If the surface of the steel has been thoroughly cleaned, and then smeared well with clean grease applied with a clean and dry rag or piece of tow, there is little tendency to rust unless the fatal mischief has previously been allowed to begin.

The superstition which some people have held, and afterwards repented of, that a barrel can be kept in good order if it is conscientiously wiped, without being oiled, is altogether vanity. Another still more vain notion is that a rifle can be shot without being cleaned for weeks at a time, and be none the worse. The fouling, it may be, does not accumulate, and creates little obstruction, but it only serves to disguise the mischief to the surface of the bore which is inevitably going on all the time.

There is no advantage in this climate, if the rifle is kept in a dry place, in attempting to stop up the ends of the bore. Indeed, plugs or corks are in this respect very dangerous things to put into it. They are often accompanied by a disposition to rust just where they are seated. Nor is the appliance sometimes used with shot guns, a rod covered with baize, and exactly fitting the inside of the barrel for its whole length, expedient or necessary for rifles. The rifle should be kept in a cover, a box, or a cupboard, to keep it from dust, which is one of the prime factors in setting up rust. If in a cupboard, any substance which will absorb moisture, such as calcium chloride or sulphuric acid, may with advantage be kept with the rifles, and will help to preserve them from rust.

A rifle which has been very thoroughly and conscientiously cleaned after firing, presumably with a wipe through as soon as the shooting is done, and a very thorough cleaning after returning home, will require to be wiped through again in the morning, and if it show no sign of anything wrong, it can then be left for two or three days without cleaning. But it is well to clean it again within a week, and if it be then put away, it will probably give no trouble if looked over about once a month. Almost everyone who shoots must at some time or another have experienced a feeling of deep disgust at finding traces of rust in the barrel on wiping it through again a few hours after a first careful cleaning. This is especially likely to happen when the weather has been wet, and it has been impossible to keep the rifle dry, as is bound sometimes to be the case. It is well in such a case to clean the oil out thoroughly with soda or soap, and then to pour a large kettleful of boiling water down the barrel, as already described. This is more likely than anything to check a propensity to rust. The water heats the barrel so that it almost dries itself at once, and having then been wiped through with great care, and the drying completed, it may be oiled and left for a little time. Special attention should be given to cleaning the chamber, which is often neglected because, not being of the same size as the bore, the cleaning of the latter hardly touches it. A rusty chamber may lead to difficulties in extraction and to rust in the breech end of the rifling. Barrels which show any tendency to rust must have no peace until they have been brought to a better frame of mind. The slavery of constant cleaning and watchfulness as to the condition of the bore is, perhaps, the chief drawback to the pleasures of rifle-shooting.

It is not easy for the eye which is not extremely well trained to distinguish between the surface of the barrel as it should be, and as it is when it has begun to lose its polish from the insidious infection of rust. The very small calibres now in vogue have, as already mentioned, much added to the difficulty. With the larger bores, and black powder, the red colour which a white patch brings out would always show at once if mischief has commenced. Many of the smokeless powders leave the bore in a state in which almost unlimited perseverance fails to bring it into so clean a state that the patch will come out unstained, and the black which does come out on the patch sometimes conceals rust, although the red colour cannot be seen. It has been the writer's painful experience more than once, in wiping through a rifle barrel of small calibre, which he had every reason to believe was in perfect order, to hear a certain scraping sound as the soft patch was pushed through it, at some particular part of the barrel. This was caused by the rough and rusty condition of the surface of part of the bore, a mischief which had already gone too far to be remedied, although previously unnoticed, and which at once condemned the barrel.

There are two problems of which the solution seems a long way off, the production of a smokeless powder which, while it meets all other requirements, leaves a neutral or non-acid residuum; and some means of removing, if not of preventing, the deposit of metallic fouling. Whether a third condition ever will be fulfilled, that of making rifle barrels of some metal which is not liable to rust to the same extent as steel, may be doubted. But there is much difference between one specimen of steel and another in its tendency to rust, and it seems not impossible that if the attention of steel-makers were directed to this point some slight improvement might be made. Meanwhile we can only accept the fact of the too easy oxidization of polished steel, and take all possible care to minimise the chance of its occurring.

Of cleaning the outside of the rifle there is not a great deal to be said. The wood of the stock should be kept well oiled, and if linseed oil, preferably boiled, is worked into its surface until the pores are filled, and it becomes perfectly water-resisting, so much the better. The inside of the barrel and the chamber require far more attention, especially from the marksman's point of view, than any other part, but the breech action and lockwork must not be neglected. More than once the writer has seen a competitor's score in a rapid firing competition spoilt by something going wrong or jamming in the mechanism, when a little care would have prevented it.

Sometimes the bolts of different rifles are interchanged by accident, and it is well to be careful that this does not happen. Only within the last year or two at a Bisley meeting the writer was appealed to as to the unfairness of a man losing his score whose rifle had jammed hopelessly in a competition with a time limit. A little investigation showed the cause: the numbers on the bolt handle and on the action were different, proving that the bolt belonged to some other rifle, and this had led to the trouble. The competitor may have been using the wrong bolt for weeks, for in deliberate firing it would probably give little or no trouble. But he went away a sadder and a wiser man, feeling that no one else but himself could be blamed for the hard luck which had overtaken him. He had evidently neither examined his rifle carefully when cleaning it, taking the bolt out habitually in doing so, nor rehearsed the very deliberate magazine fire called for by the conditions of the competition. Although the action of our Service rifle gives little trouble in these respects, it is well to see that all the working parts, and especially the spiral spring and the striker, move freely, and are not hampered by dirt. They will not often require overhauling. The pull-off requires occasional attention. It is liable to alter, even from the small amount of wear which it gets, since the strains on it are considerable, and then it may become so heavy as to be difficult to discharge, or so light as to be a source of danger. It should be kept to about 6½ lb., 6 lb. being the official minimum limit for the Service rifle, and unfortunately also the lowest weight which seems compatible in our rifle, as at present made, with the absence of liability to be jarred off by the rifle falling or being knocked.

The method of adjusting the pull-off is by making some small alteration in the shape of the sear nose, which is connected with the trigger, or of the bent or notch on the under side of the cocking-piece, against which it fits. It requires very good judgment and very careful handling to do this satisfactorily. A very small alteration in the angle at which the two parts are in contact may easily make a large difference in the pressure on the trigger necessary to discharge the rifle. The parts are tempered too hard to be filed into shape, but a small piece of some fine oilstone applied with care will, as a rule, do all that is required. To test the weight of the pull-off an arrangement is commonly used consisting of a hook which passes over the trigger, and to which is attached a rod carrying weights which can be varied. A very portable and simple means of trying the pull-off is by a spring balance, which will clearly show differences of a quarter of a pound, and is attached to a strong wire, bent so as to pass across the trigger. Whether the balance or weight be used, care must be taken that the stem of the hook clears the woodwork of the grip, and that the pull is given at the same angle as that used in pulling with the finger, that is, diagonally upwards across the stock. If the barrel of the rifle be held perpendicularly, as was the rule in old days in testing with a weight, it rests more nearly on the end of the trigger, and thus obtains an unfair leverage. Where sporting arms are concerned it is only necessary to have the pull-off from 3 to 5 lb. in weight, according to taste, the limit of reduction being that at which there arises danger of accidental discharge from a blow on the rifle. For a rifle to be used in competitions we no longer follow the rule of Ezekiel Baker, who says:—'A rifleman, to ascertain when his trigger pulls too hard, is to suspend the trigger of the rifle on the forefinger of his right hand, with the muzzle downwards, with the lock on full cock (taking care the piece is not loaded, as that would be very dangerous,) which should just bear its own weight; and if it requires considerably more than the weight of the piece to pull off the trigger it is too hard, and will take the rifle out of its right direction when fired.'

It is well, on the other hand, not to run too close to the limit of 6 lb. prescribed both by regulation and by the National Rifle Association for the Service arm. A little wear, even sometimes the heating of the mechanism from firing, may make a considerable difference to the pull-off, and it has happened more than once to a competitor who thought he had a margin to spare that he has found himself, after making a big score, hard put to it to prove to the range officer that his trigger would lift the test weight without being discharged. There have been rare cases in which inattention to the condition of the pull-off has ended in the disqualification of an individual, or of a whole team, in some important match, and the fruits of a little laziness and carelessness have given cause for lasting regret.

One of the points to notice is that the pull-off must be clean and easy, and be released without any appreciable delay when the trigger begins to move. It is very unpleasant, when one expects the slightest movement of the trigger to release the striker, to feel it drag a little before it actually does so. It is important to keep the sear and the nose of the full bent in which it engages, free from dirt, and slightly lubricated, and that the whole width of both should be in contact. The same applies to all the moving parts of the lockwork. The easy and regular pull of the trigger is a matter worthy of serious attention, especially for shooting at moving objects, and it should be adjusted only by expert hands. The really successful shot never neglects details of this kind.

We have already touched upon the necessity for keeping the butt of the ·303 screwed up tightly to the strap of metal behind the action, into which it fits. The band and nose-cap which bear upon the barrel should not be so tight as to pinch it in the least, else the shooting is affected; and this caution especially applies to the opening in the nose-cap for the barrel, which gives little or no margin if it is not quite correctly placed for the barrel to pass through it. The back sight should be kept in good order; the hinge should be kept oiled so that the spring has no difficulty in lifting the flap to the proper position when it has been raised so as to be nearly upright; and the leaf should slide easily, but not too easily, upon it. Sight protectors, both for fore sight and back sight, should be habitually used. The magazine should be occasionally taken out and looked to, to see that it is in working order. The shooter, in fact, should conscientiously do his duty in every way by the rifle if he wishes it not to fail him in any point at some critical moment.

In the case of the Match rifle the sights require some extra care, and the screws by which they are attached to the stock and the barrel need occasional testing to see that they are tight. All screws connected with the sights should occasionally be tightened up, since it is almost an ineradicable habit with them to work loose from the jar of firing, and the writer has known men break down in important competitions from this easily preventible cause. The sliding parts should be kept clean and sufficiently lubricated, but should be watched to see that they do not wear so loose as to be capable of shaking or shifting. The aperture of the back sight, and the actual bead or ring of the fore sight, must occasionally be wiped free from the little deposit of dust which is apt to settle upon them because of the slightly oily condition in which it is advisable to keep all the steel or iron work connected with the rifle. To sum up, the rifleman who takes the trouble to keep his weapon in first-rate order will be repaid even for the drudgery of having to dirty his hands and scrub at his rifle when he comes in hungry, tired, and perhaps wet, at the end of a day's shooting. It is not easy to be properly methodical in this matter; but he who allows himself to acquire careless or irregular habits will regret it too late, when his favourite weapon has to have its barrel condemned as old iron, or when some preventible failure in the weapon deprives him of success in a competition. If barrels wear out, or rust out, more easily at the present day than in old times, those of military arms are, at all events, not very expensive to renew, but this is small consolation when nothing remains but to throw away a cherished and trusted barrel with which high scores have been made.

It is well that the user of rifles should understand how to take the lockwork to pieces. To be in good working order it should be very clean, and the moving parts slightly oiled with good machine oil or similar lubricant. It is probably unnecessary to give the caution that no polishing or cutting substances whatever should be used in cleaning any part of the lock. Sometimes, as after exposure to rain, a few minutes devoted as promptly as possible to cleaning will save much subsequent trouble. The lockwork of expensive English guns and rifles is not designed with any notion of rendering it easy for the amateur to deal with it. The very bruising of the screw-heads from the want of turnscrews of precisely the right size, form, and temper, and of suitable means for holding the weapon firmly while they are applied, will spoil their highly finished appearance, and, perhaps, make work for the gunmaker. With cheap and machine-made arms, such as magazine rifles, there is usually little difficulty in taking apart the components of the lock. Most of the Continental rifles are so arranged that this can be done without any special tool, although it is well rather to be shown the method of doing so by some one who understands the particular mechanism in question, than to depend upon the light of nature and mere guesswork. Generally speaking, it is far easier to take to pieces a bolt or a lock that one does not understand than to put it together again. The view taken abroad seems to be that every part of the mechanism of the military rifle should be easily accessible for cleaning. In the case of our own rifle it was deliberately thought better so to arrange the bolt that it cannot be taken to pieces without a special tool issued only to armourers. The soldier has often been known to change bolts with a friend, whether accidentally or as a token of amity it is not easy to say, and it is considered that if he had easy access to all the smaller parts of the mechanism, some essential piece would often be broken or missing. The writer believes rather that the desire to take the mechanism to pieces merely for the sake of playing with it arises almost entirely from the mystery which is made about it. Now that the components of a lock are comparatively few and simple, and spare parts can always be substituted for broken ones, and, it must be added, now that the fighting man has intelligence which must be cultivated, there seems no reason why he should not be made to be his own armourer when necessary, so far as cleaning the mechanism of the bolt is concerned. If this were part of his duty, he would not be found playing with it when he once understood it. There cannot always be an armourer with special tools at hand if any obstruction arises on service from dirt, or if a spare part has to be substituted for a broken one.

Miss-fires or hang-fires occasionally happen, and are extremely annoying. Speaking generally, the Service ammunition is extraordinarily free from them, although a few years ago there was an epidemic of hang-fires in the cordite cartridges of a particular period, which caused many searchings of heart at the Bisley meeting. In that case the fault undoubtedly lay in the cartridge, but it is safe to say that in nineteen cases out of twenty the cartridge is not to blame for hang-fires. It is sometimes a short striker which causes them; sometimes the mainspring gives an inadequate blow because it has grown weak, or even because its freedom is hampered by dirt, or by the action not being properly closed.

The various qualities of different kinds of smokeless powder lead to their being sometimes loaded in cases fitted with a cap which will only just ignite them properly, and when this is the case hang-fires and miss-fires are likely enough to happen. It would not be very far from the truth to say that most modern smokeless powders require each a special cap to give the best results. The writer has tried to fire a charge of cordite in cartridge cases made for black powder quite without effect, and has found on opening the cartridge that the cordite had been blackened by the flame of the exploding cap without being ignited. Miss-fires in sporting or military rifles are at the best annoying, and at the worst fatal if they occur at some critical moment with dangerous game, and it is doubly necessary to be sure that every possibility of them is so far as may be removed. The target marksman regards such things with more equanimity, but even he must remember that a bad hang-fire may delay ignition long enough for the rifle to have been brought down from the shoulder, and possibly to be pointing in some less safe direction than that of the target before the charge is exploded. It is a great test of steadiness when a miss-fire or a hang-fire unexpectedly occurs, and men are sometimes surprised to find that they give a bob forward after pulling the trigger. This perhaps represents the attempt to meet the recoil of the rifle by moving the body. If the aim has been held steadily a hang-fire will often produce no appreciable effect upon the flight of the bullet, although its tendency is to make it strike somewhat low. It is a fair cause for complaint if a hang-fire occurs in a rifle competition in which the firer does not provide his own ammunition, and where the rifle cannot be blamed. Fortunately such unpleasant events are of rare occurrence with well-made cartridges, and it is no doubt a source of just pride to those responsible for making the Service cartridge as well as to the makers and viewers of the Service rifle, that out of hundreds of thousands of rounds fired, those which give any reasonable cause of complaint may be counted upon the fingers of one or two hands.

CHAPTER XIV

IMPORTANCE OF TARGET SHOOTING—SKILL BEGETS CONFIDENCE—INDIVIDUAL SKILL THE BASIS OF GOOD COLLECTIVE FIRE—RAPIDITY IMPORTANT—RIFLE RANGES—SCREENED RANGES—THE SWISS SYSTEM—SKILL AS AN ELEMENT OF SAFETY—SPACE NECESSARY BEHIND THE BUTT—OFFICIAL REQUIREMENTS AS TO RANGES—UNDERGROUND RANGES—IRON TARGETS AND METHODS OF MARKING WITH THEM—THE RINGING BULL'S-EYE

ALTHOUGH the ultimate object of all rifle practice is to be able to make effective shooting either at game or at an enemy, the only way really to learn the mastery of rifles is to practise constantly with them under much easier conditions. There is very great value to the beginner in practising at the very shortest distances with the very weakest rifle, so long as it is accurate enough to respond well to his aim; and when he has in this way learnt the rudiments, he can at once make very respectable practice at longer ranges, unless the weather be very difficult, with a full-sized weapon. Why is this? Surely because he has acquired familiarity with the handling of his arm, and the proper drill and method of its use, things which, learnt on the smaller scale, are entirely applicable to what is done on the larger. Similarly, skill at the target, although it is the fashion in some quarters to sneer at it as not practical, yet is eminently so, for it is at the target only—that is, under circumstances which test skill by removing so far as is possible the element of chance, and by enabling faults of judgment or of aim to be corrected as the shooting proceeds—that the useful lessons can be given upon which all effectiveness of fire really depends. It is quite impossible that any man should make good practice in the field at marks which are not easy to see, and the distance of which he does not know, unless he can at all events shoot accurately at known distances and visible marks. It is of immense advantage to him if, when he has acquired proficiency in target-shooting, and a proper measure of the confidence which proficiency begets, he can obtain practice at something more like the practical marks of sport and of war than a measured range will afford. Yet to expect men to do any good work at all at unknown distances, and at moving objects, perhaps not very easy to discern, when they have not been grounded in the rudiments, and are incapable of performing reasonably well with their weapons when no such difficulties are presented, is much the same as to expect a difficult piece of music to be played upon the piano by a performer who has hardly learnt the scales, or a long break at billiards to be made by a learner who cannot be depended upon to make the easiest of cannons. This applies equally both to sporting and to military shooting. The target shot is not necessarily incompetent in the field. On this point we may cite an account of Mr. Gould's shooting given by Mr. Salem Wilder as follows :—

'In regard to the marksmanship of the cow boys, when dismounted, a simple incident will illustrate :

'Perhaps ten years ago Editor Gould took a trip along the frontier, and carried his Sharps rifle with him. He stopped at what was called an hotel in Dakota. It was in the winter, and many cow boys were there at that time. They told stories of their great marksmanship, and as Mr. Gould did not pretend that he could match their shooting, he became, in their opinions, simply a fashionable marksman. It so happened that a severe snowstorm came and covered the ground some two or more feet deep. Before long provisions began to run short in that place, but, as luck would have it, a considerable number of antelope wandered into that vicinity. All the riflemen were on the alert; and among them our rifleman from Boston.

'He outshot every one of them, killing two antelope to any other hunter's one—dropping one antelope 468 paces from where he stood when he fired. This at once made him the hero there, and those cow boys were thoroughly laughed at for allowing themselves to be so badly beaten by the Boston fellow who they supposed could not shoot.'

The man who has stag fever badly in Scotland, or who misses the best chance of his season at antelope or mountain sheep in wilder lands than these, is the man who has no intimate knowledge of his weapon, and no confidence in his own ability to use it with effect. His mind has never been painfully convinced by experience that unless the aim is right, and the reckoning of the distance right, and the shot fired with care, and with due regard to conditions of weather, the work of hours, if not of days, will inevitably be wasted. The great danger in war, as in deer-stalking, a danger far greater for the novice than for the old hand, is that excitement and flurry may lead to absence of self-control. Large or dangerous game has often been missed at almost incredibly close quarters by men who ordinarily are good shots, but have had no experience of such exciting circumstances. The whistling of the shell overhead, the thud of the bullet near at hand, in war, are most demoralising to those to whom they are a novelty, and there is every excuse for men to be overpowered by excitement. Yet these are the very times at which coolness and presence of mind are the most valuable qualities a man can have. One who had seen a great part of the fighting in Natal in 1899–1900, wrote home after some months of work that the British soldier had now learnt the tactics of war as practised by the Boers so well, that he was their equal in all respects but one, that when he came within shooting distance of his enemy, he had not the necessary confidence that he could hit his enemy before his enemy could hit him. In such circumstances, confidence is born of nothing else but skill and the consciousness of it. The secret of skill and confidence is that the shooter should be intimately familiar with the handling and the use of his rifle, and this he can only become by constant practice at targets, both easy and difficult. The old-fashioned Boer became an expert, it is said, because as a boy he used to be given one cartridge and sent out to kill a buck, with the penalty hanging over him of a thrashing if he returned home empty-handed without the cartridge. He learnt in a hard, but a very practical school. It is the backwoodsman, or the hunter in wild countries, whose rifle is never out of his hands, who becomes practically the most expert of shots, in addition to acquiring all the lore of the wood, the veldt, and the prairie, and all the quickness of eye which the dwellers in towns, and those whose occupations keep them largely indoors, may never hope to emulate.

In default of such constant practice, much can be done to make good shots of men who only practise occasionally; and with regard especially to military efficiency, whatever can be done should be done. Lord Wolseley has said that all the object of drill and manœuvre is only to bring the soldier into the position in which he can use his rifle with effect, and that if when he gets there he cannot use it, he is an encumbrance to the army. Lord Roberts's belief in the primary importance of good shooting may be judged from the pains he took by example and in every other way to encourage target matches and practice while in India, and the interest he still shows in the subject. It is to be feared that the change of conditions from the old days, when the arm of the British soldier was a weapon quite unworthy of skill, has been too slowly understood. Rifle-shooting is still called 'musketry'—of all inappropriate terms—in the army; we still equip men with clumsy pouches such as were suitable to carry muzzle-loading ammunition; we are still slow to recognise that there is any merit for military purposes in a high degree of individual skill. Yet this is a lesson which we might have learnt, if not from the American riflemen or the Continental Jägers more than 100 years ago, at least from the Boers in the last 25 years. We have learnt the practical importance of concentrated collective fire, but it is hardly sufficiently realised that the concentration of collective fire depends on the individual skill of the individual man, and that the effect of the fire of a given number of men is only the aggregate of that of the individuals added together. The writer had an instructive experience on this point when attending a course of instruction at the School of Musketry at Hythe some years ago. The class, which consisted of a little more than seventy officers, was divided into small sections of five or six each, under the charge of a sergeant-instructor. There was one squad, two members of which were experienced shots, and in the first part of the shooting done in connection with the course, the individual practices, they were quite at the top, while the other members of the squad, as the result mainly of the teaching they had received, also did well. The instructing officer expressed himself to the following effect: 'This is all very well, but you will see when you come to sectional practices that it will be different. Our experience is that the shooting made in volleys, &c., by third-class shots is better than that made by men who are good shots. We always find it so.' Whatever doubt such a statement might provoke, it emanated from so authoritative a source that one could not but expect the event to show some justification for the opinion. But it showed none. The squad which had done so much better than the others in individual shooting was even further ahead of them in the collective practices, a proof of the rather patent fact that, when men have been properly taught, individual skill is most valuable in sectional shooting. It is likely enough that if half a dozen men who are good shots in their own way, and quite unaccustomed to subordinate themselves in shooting to the command of another, are made to fire volleys—or to fire at all—when smartness and rapidity are important, they will not do so well as inferior shots who are accustomed to these conditions; but their failure is due obviously, not to the fact that collective firing brings the inferior shots to a higher level of skill, but that it tends to level down the skilled individual shot who has not been adequately drilled to a point far below his real capacity. It was shown clearly enough on the occasion that has just been spoken of that the individual skill of the accomplished shot still maintained its superiority when he had had the necessary additional drill and training. Yet, curiously enough, this fallacy about the comparative, or rather, the actual superiority of the bad shot dies very hard, and is at the present time not altogether extinct. It is, in its way, as ridiculous as the theory of ancient gunnery, that, owing to some peculiar attraction of water a gun would not carry so far across a river or over the sea as over dry land.

The essence of collective firing is to throw a thick shower of lead upon some group or line of the enemy, or upon some piece of ground which is known to be held by them, even though, as has been so constantly the case in South Africa, they cannot be seen. It is quite obvious that when a section or a line of men is firing in real earnest at such a mark the man who discharges his rifle carelessly in the direction of the enemy, so that the bullet strikes (as in field-firing it may often enough be seen to strike) a long way short of his companions' shots, and perhaps no great distance in front of the firer, is merely wasting ammunition, is 'an encumbrance to the army,' and is, in fact, about as effective for fighting purposes as if he were a Chinese soldier carrying a shield with a hideous face painted upon it to frighten the enemy. Further—and let this appeal to the British mind—he is an utterly bad investment of the money that has been expended on his keep and his training. The increased cost of a really sufficient provision of ranges and ammunition for the soldier's constant practice should be more than well repaid by his increased efficiency and improved *morale*.

Familiarity with the handling of loaded arms is the only way to produce a feeling of security among those carrying them. The present writer ventures to think the training of our auxiliary forces, with which he is most familiar, very inadequate in this respect. It is not right that the training of any part of His Majesty's army should be such as to make the fear of an accident from the handling of loaded arms a prominent feeling of those going out to practise company or battalion field-firing. Very different was the shooting, at the end of their training, of a company of Swiss recruits, whom the writer saw do field-firing at the end of a day's route-march a few months ago. As the men came near the ground, and before they had extended for attack upon a row of head-and-shoulders targets some hundreds of yards away, the magazines were charged and rifles loaded, and the safety-bolts applied; these loaded rifles were then handled in close order exactly as if they had been empty. The men extended, and as they came within sight of their objective over the brow of the hill, first stopped, and then advanced in deer-stalking fashion on hands and knees, there being no cover. In the firing itself there were two notable features, one was that hardly a shot struck materially short of the line of targets, and that the vertical concentration of the fire was excellent; the other, that the left half-company, which was at an interval of only 20 or 30 yards from the right, at a certain stage in the fight doubled forward from about 800 yards to a second rise of ground some 400 yards from the objective without increasing its interval, and took up the fire, while the right half-company continued a cool and well-aimed fire close past its flank, every man being in full view, without its occurring to anybody that there could be any danger. Nor, indeed, was there any. In field-firing in this country, so far as the writer knows it, such a movement, though tactically quite correct on the ground in question, would have been thought far too dangerous to be attempted. This Swiss company consisted of a quite normal batch of recruits, who were within two or three days of completing their first training of forty-five days. For them drill and manœuvre are reduced to their simplest elements, and while no attempt is made to give the polish of the barrack-square, much care is given to the shooting. The chief secret of the success of this part of their training remains to be stated; it is this, that practically every man has become a safe and proficient shot by learning to shoot on the club range of his village before he is old enough to be called out for training.

The importance of target practice hardly needs to be further insisted on, and there are signs at the present time that it has been driven home to the minds of the country, both military and civilian. Many a man who was a stranger to the rifle has in the last twelve months familiarised himself with its use, and under conditions far easier than those of old days. The troublesome business of loading every shot separately from the flask and the bullet pouch, and the weariness of the long interval between the shots which used to be necessary for all the elaborate operations of loading, have long been eliminated. The marksman practising alone can fire as quickly as his shots can be marked, nor is he liable to be troubled with a bruised shoulder after a few rounds.

One point of the soldier's training, which is recognised as indispensable in the case of the sportsman, has hitherto been too much neglected. At the target and in early instruction, deliberate firing is excellent, and, where circumstances allow, no amount of care is too great to be expended in making a sure shot; but it is on the occasions when the mark is perhaps a man in quick motion, and only exposed to fire for a few seconds, that the man who can only shoot slowly becomes comparatively useless. In hurried shooting accuracy must to some extent be sacrificed, although a good shot, who is not used to firing quickly, will be surprised to find how successful he can be in doing so, after a few attempts. There is no practice more valuable than that of firing at a target shown only for three or four seconds at a time, and the main part of the necessary quickness of manipulation can be acquired at home by practising with dummy cartridges. A new form of rapid shooting has been introduced by Lord Roberts in the Commander-in-Chief's Competition at Bisley. It consists in crouching behind real or artificial cover, suddenly raising the head and body high enough to fire a rapid shot over it, and then at once dropping again out of sight. This is a sound form of practice in its essence, but to be of any value it requires that the soldier should first have been trained to shoot well deliberately and then rapidly both at fixed and disappearing targets. Ranges then, so far as circumstances allow, should be such as to give accommodation both for practice at fixed targets at all distances, and at moving and disappearing targets at short distances.

Under the heading 'rifle range' we may class any place arranged, temporarily or otherwise, so that a rifle may be safely fired upon it at a mark. It is hardly possible to carry the definition further than this, since the rifle range must include a place where rifles are fired at 12 or 20 yards, for the purpose of sighting them, as much as one for testing the accuracy of military weapons at a mile or more. A gunmaker's range may be under cover in a cellar, or it may be on the roof of his factory. Subterranean ranges of short distance have been made, and also protected short ranges in the open on the housetops—an old device of Birmingham gunmakers. Where shooting is required, as it is by gunmakers, in the midst of towns, the stop-butts must of course be of artificial construction; and, unless it be in the open air, various difficulties of lighting the range and of covering it in at the sides have to be surmounted. The necessary protection from the danger of a wandering bullet must be proportionate to the power of the rifle employed. Where a range is entirely enclosed, so that no bullet can possibly get out of it by ricochet or otherwise, it need be no longer than is necessary to give the distance fired at, with some room for the targets at one end, and for the firing point at the other. In the open air the case is different. The very long distances covered by the bullets of modern rifles when fired at a high elevation, or when they have risen after grazing the ground, constitute an element of danger which requires to be provided against very carefully. Very many attempts have been made to meet the difficulty by interposing a screen, or system of screens, between the firing point and the target, so that the mark is seen from the firing point through one or more openings like small windows, and that any shot fired at all wide of it should be intercepted by a screen and caught. Such an arrangement sounds as if it were extremely easy to make. So it is, in a great degree, if planned with real care and full knowledge. Given that the trajectory of the rifle is perfectly known, that the firing is to be done from a fixed distance, that only a single person is to fire at each target at a time, and that there is no objection to the view of the target being circumscribed within the narrowest possible limits, it is not difficult to devise an arrangement which will prevent any direct shot from reaching as far as the target unless it strike either upon it or close to it, and one which will provide for the interception of shots that might ricochet after striking the ground before getting to the target. There is, in fact, little difficulty in stopping ninety-nine shots out of a hundred, but it is at this point that the real crux of the problem arises. It is just the protection against those few shots that may graze the edge of an opening in the screen, and so take an erratic course, that is most difficult to arrange. The history of the safety range at Wormwood Scrubbs is an interesting example of this. It is a range for firing at a distance of 200 yards. It was planned originally before the introduction of the ·303 by skilful engineer officers upon a scheme similar to that of ranges in use in Belgium. Screens intercepted the wider shots, and banks topped with a soft substance were provided for the ricochet. The difficulty with a ricochet bank, as with a screen, arises from the few shots that may graze the top of it and fly off at an angle. It had been found in Belgium that if some easily penetrable material, such as spent bark from a tannery, were laid on the top of the bank, it prevented the bullets from flying off at an angle. This arrangement was adopted, but it was found as soon as the firing began that the Martini-Henry bullet, because it had a higher velocity than the Belgian bullet, had more determination to ricochet, and that the tops of the banks became a source of danger. The openings in the screens were narrowed and sloped like a funnel, so as to lead the bullets into the next screen; and by such modifications the range was made safe for the Martini-Henry rifle. The introduction of the ·303, with its flatter trajectory, higher velocity, and harder bullet, brought conditions more difficult to meet, but as the result of much experience the range at Wormwood Scrubbs now seems really to be proof against the escape of bullets. To make such a range costs much money, and even then its utility is very limited, nor can there ever be a feeling of perfect certainty that it is impossible for a bullet to escape. Mr. Morris, the inventor of the Morris tube, some years ago devoted much attention to designing safety ranges, and to a large extent solved the problem, introducing an arrangement known as a ricochet chamber to catch any shots which might glance off the edges of the openings in the screens. One of the difficulties about the screened range is that the safety of it depends upon the rifle being always fired from the same point. It is necessary, therefore, to make arrangements whereby, whether the shooter is firing standing, kneeling, or lying down, his rifle should always be at the same height from the ground, so that the course of the shot bears the same relation to the intercepting screens and appliances. At Wormwood Scrubbs this is accomplished by having the firing point arranged in stages, one behind the other, so that the rifleman, in whatever position, can find some part of the firing point which will bring his weapon to the proper level. Another drawback is that the expense of making such a range, fitted with screens carrying iron or steel plates, raised upon timber framing, from brick foundations, with the cost of making the firing points in stages, &c., amounts to a large sum. Screened rifle ranges in the midst of populous places do not exist in Switzerland. There are said to be some at St. Petersburg. At Liège there is one, and it is proposed to try some on similar principles in this country, as the system is less costly than that of Wormwood Scrubbs. The protection is given by a succession of $\frac{1}{4}$-inch steel plates, 2 or 3 feet square, on each side of the line of fire just in front of the firing point. These are set to slope inwards, so that any bullet striking on one side is deflected towards the other. Beyond them is a continuous tube or chamber of steel long enough to account for any bullet deflected from the steel plate. Another embrasured passage on similar principles leads from an opening in a screen a short distance further forward. Shots passing through this, if they do not hit the target or butt, can only strike so close that the ricochet is caught. Ricochet banks may be introduced. A great safeguard against ricochets is that the soil should be quite loose and free from stones. There are a fair number of partially screened ranges in Switzerland, but the background behind the target is almost invariably such as to solve in a great measure the question of safety. Both mountains and tracts of forest are so common in that country that the ranges do not depend on the screens for safety; nor do they, even where the background is less favourable. There is a range at Lucerne which has existed for a good many years. It is 300 metres long, and has twenty-five targets ranged against an artificial butt. There are three screens which would intercept bullets accidentally discharged too high; these screens consist of what is as good a material as any, a layer of shingle between two sheets of timber. There is nothing whatever to prevent a ricochet from a shot accidentally fired low passing over the butt. The firing point, as in so many of the Swiss ranges, is a closed gallery, a separate stall being partitioned off opposite each target. Such a range would never be passed as safe in this country, in spite of its screens, unless it had a clear 2,000 yards, at all events, behind the butt in the line of fire. Yet, since the range was set up, a couple of houses have been built on slightly rising ground in the direct line of fire, within about half a mile of the butt. It appears that no complaint is ever received, and no question of danger arises from these. Nor is this all, for a footpath crosses the line of the range close behind the butt, and is a good deal used. In this country we should have a look-out man with a flag at one side, if not both sides, of the range, and he would signal when anyone passed on the footpath so that the firing might be stopped. No such provision is thought necessary at Lucerne, and the wayfarers stroll across past the rear of the butt with the greatest possible indifference to the firing. Yet it seems that there has never been an accident upon this range, and no one thinks of suggesting that it should be closed. It is likely, however, that before very long the people of Lucerne will have to find a fresh shooting ground, since the military authorities do not care to run even such risks as are here apparent. In this country a range situated like that at Lucerne, with the line of fire crossing not only the footpath and houses, but woods, which in spring and in summer are the resort of many of the inhabitants on a Sunday (and Sunday afternoon is the chief time for shooting), would not be tolerated for a week. What, then, are the elements of safety which exist in Switzerland, and are absent in England? There is at all events one very positive one. In this country a range is not considered to be safe except when a rifle discharged anywhere at all in the general direction of the target cannot be a source of danger to anybody. That this is really the kind of standard of safety which has always prevailed is proved by the singularly unwise custom in the training of the soldier, that in firing a course at different distances he has been allowed to go back to a longer range, when he has perhaps missed almost or quite every shot at a shorter one. It used to be officially considered that 'practice' must be valuable to him, even when in discharging his rifle he produced no effect at all beyond endangering the life of some quadruped or biped in the remote distance. Such a view needs only to be stated to stand condemned. How can any range be safe when used in such a way? If a man cannot hit the target at 200 yards, he should be taken to 100 yards and kept there until he can perform respectably. If he cannot hit it at 100 yards, he should be taken to 50. Nor should the beginner shoot except under good conditions of weather. In Switzerland every man and every boy, even if he does not in some degree inherit an aptitude for the rifle, at all events considers it a disgrace not to be able to use it. The young shot does not go to the target until some friend has carefully instructed him in the rudiments of shooting. He has perhaps learned the elements of shooting and graduated as a member of a cadet corps, or has been carefully taught to aim and shoot steadily with a crossbow. From this it is an easy step to learn how to hold and manipulate his rifle safely. If, when he gets to the range, his shots fly at all wildly, his practice is quickly stopped, and he must master his weapon better, whether at home, or at some shorter distance, before he again tries his fortune with other competitors. The public opinion of men and women alike is brought to bear upon him, for the man who cannot shoot is thought to be the worst kind of duffer; it is constantly directed, as we wish it were in this country, not to the obstruction of shooting, but to its encouragement. Every town or parish authority has the responsibility of providing a range or shooting ground, on which targets are set up when needed, and has to bear the cost of any damage done to crops or timber by the use of it. It is realised there, where the frontier is some artificial line offering few or no obstacles, watched by military forces on both sides, and whence invasion might conceivably come at any time, with or without twenty-four hours' notice, that to serve, and to serve efficiently, in the ranks of national defence is the first duty of every young man. The shirkers, if there be any, do not carry public opinion with them. It is understood, too, that rifle practice is an absolute necessity, and the man who attempts to obstruct it, or to interfere with it from selfish motives, declares himself a public enemy. There is no closing of ranges from the exaggerated fears of some imaginative landlord; or of some owner or occupier who puts gain first and country afterwards. As the necessity of constant and universal shooting is recognised, there is no exaggeration of its dangers, which are indeed small enough. In this country it does not seem as if the range difficulty, so far as military training is concerned, could ever be finally solved until some sort of efficient compulsory procedure can be brought to bear when necessary for the acquisition of land, and of the right to fire over it.

In constructing a range for military purposes it is usually considered necessary to have a clear space of 2,000 to 3,000 yards behind the target, and to leave a margin on each side of the direct line of fire. It is of little use, however, to provide against accidents which may happen from the rifle being accidentally discharged when pointed at an angle of 30° or 40° upwards. It is quite as likely to be discharged accidentally when pointed the same amount to one side or the other of the proper line. In this respect no range can be made absolutely safe. All that can fairly be asked is that shots which may accidentally pass over the top of the butt, or which may strike the ground short of the target, and ricochet onwards, should be provided against. It is probable that no ricochet shot will travel much more than 2,000 yards in all from the muzzle of the rifle. It is of no use to attempt to apply indiscriminately any rule as to the distance necessary behind the butt. A range situated so that the targets are backed by a steep hill of chalk or other formation will require very little distance behind the targets to make it safe, provided always that the shooting is reasonably careful, and it should never be otherwise. The writer remembers a painful sight, not uncommon in his early volunteer days, at the prize meeting of an isolated company in the country. The men fired at 200, 500, and 600 yards. Practically every man in the company fired whether he was a good, indifferent, or bad shot. There were some few men who at 500 yards did not hit the target at all, yet these men solemnly lay down and fired seven shots at 600 yards, with an equally clean result. The proceeding sounds foolish enough, but it was a natural corollary of an official arrangement, now fortunately long ceased, and lamented by nobody, which provided that a

Volunteer who in the course of the year discharged upon a rifle range sixty rounds of ball ammunition in any direction, into earth, air, or water, or it might be by some accident the target, was thereby constituted, so far as musketry was concerned, an 'efficient volunteer.' It cannot be too clearly understood that the safety of a range depends mainly on the skill of the firer. On Sir Henry Halford's range at Wistow, which dips slightly between the long ranges and the target, the haymakers have been known to continue working in the direct line of fire while he was shooting at 1,000 yards, and to refuse to move to another part of the field. Why should they, when nearly every shot roused the echoes with the clang of the ringing bull's-eye? The bullets were passing many feet above their heads, and there was no real danger.

We have wandered somewhat from the actual question of the construction of ranges. It is well that so far as possible the ground should be such that the targets can be seen from any point in it. This will save great expense in building up firing points at certain distances from which to see the targets over intervening ground; and it will also enable the range to be effectively used at all distances, known and unknown, for field practices. The butt should be high enough to catch all shots aimed at the target that deviate from it. Even where there is a hill close in rear of the butt, it is often necessary to scarp it away or to make some sort of erection from which the bullets will not glance, for unless the hillside is very steep a shot fired from below it is not unlikely to glance off its surface. In open ground, where the butt is the only thing that will intercept the bullet for a long distance, all kinds of materials have been used to make it. Earth, faggots, sleepers, brickwork, a double screen of timber packed with shingle---one or other of these is usually the chief factor. The butt should be as high as it can conveniently be made, and give a fair margin on each side of the target; 30 or 40 feet is not too high for a butt on flat ground. The danger which arises from ricochets is diminished if the butt is big enough to stop nearly all those which strike near the target. We are here speaking, of course, of a butt for ordinary use for instruction and practice; a target used only by skilled shots does not require nearly so large a butt behind it. One great element of safety with a high butt should never be neglected. The deviation of shots above or below the target is on the whole about equal, and if the target be raised so as to be well above the ground level, a large number of shots which would otherwise strike short and ricochet will find their billet in the upright bank below the target. The old iron targets, which have disappeared so much in late years, themselves stopped the bullets which struck them, and broke them up into fragments, but penetrable targets allow the bullets to collect in the bank, if there be a bank behind the target. On the Bisley ranges and others on which much shooting is done, a considerable sum is obtained every year from the material of the bullets dug out from behind the targets; and it is curious to see how the surface of the soil is all shot away behind the target, and especially behind the middle of it. Where a wall is used as a stop-butt it is not uncommon to have in front of this a thickness of sand packed behind a timber framing, in which the shots remain. In Italy we have seen the whole surface of a butt packed with a layer three feet deep of old clothes and rags, containing one might well wonder what abominations of dirt and infection, which served to protect the wall and to catch the bullets. The best background of all for a range, if a steep hill is not to be had, is water—water, if possible, on which there is no boat traffic. The sea is an excellent background, but a look-out requires to be kept for boats. Mr. Metford used to improvise a range for shooting rifles at 2,000 yards, and even 3,000 yards, by firing in calm weather at some rock projecting out of the water on a rocky unfrequented coast, in Devonshire or elsewhere, and watching the splash of the bullet in the water with a powerful telescope. It is not suggested that this proceeding is suitable for general adoption. It has been maintained with much reason that the large reservoirs of water companies might be worked in this way into a scheme of ranges, being utilised to afford space behind the target. For short distance practice, that is, for sporting rifles or miniature rifles, there is nothing better than a disused quarry or chalk-pit, such as may be found in many parts of the country.

The following extract from the official Musketry Regulations of 1898 shows the various requirements which have to be met in laying out a military range:

'In selecting a site, it is most important that the range be as near barracks as possible, and that the ground behind the targets should be thoroughly commanded from certain points sufficiently clear of the line of fire to ensure safety to the look-out men, in order that the firing may be easily stopped when necessary: a range down-hill is generally to be preferred to one up-hill, as being more easily commanded. It is essential to secure the right to fire over the ground beyond the targets to the extent required, if it be not desirable to purchase it.

'When the site is level, the length of ground behind the targets should be not less than 2,000 yards; less distance, however, will be sufficient if a steep hill rises in rear of the targets; no hard and fast rule as to the distance required behind the targets where the ground is not level can be laid down: each case must be considered on its merits. The margin on either flank should gradually increase from 100 yards at the stop-butts, to 250 yards at 1,000 yards in rear, when the ranges are parallel; but when the ranges converge towards the targets, the breadth required as allowance for the divergence of shots must vary according to the degree to which the ranges are made to converge.

'The height of the stop-butt must vary according to the nature of the background: under ordinary circumstances it need not be more than 14 feet high; when firing seaward, 2 feet above the top of the target will be sufficient so as to form a background to the target. If on a plain, and the distance behind the target is not more than 2,000 yards, 40 feet will be necessary. Care should be taken that the butt projects at least 18 feet beyond the outside edges of the flank targets. The distance of the butt from the canvas targets depends very much upon the nature of the material used for the butt; it should not be less than 50 feet; and 100 feet is much better.

'In some cases the targets can be so placed that the nature of the ground immediately in rear of them will render the construction of a stop-butt unnecessary; in which case, to be of use in stopping bullets, and thereby ensuring the safety of the public, the ground immediately in rear should rise at an angle of at least 45°; if at a smaller angle it should be scarped; if this is not done it would, instead of acting as a stop-butt, increase the chance of ricochets, and therefore be unsafe.'

The following is extracted from the Official Manual issued in August 1901: 'For penetrable targets, whatever apparatus or pattern of frame for holding the targets is to be adopted, the requirements of the gallery for markers' butts are practically the same, the conditions to be fulfilled being—

'(*a*) Height not less than 6 feet 6 inches;

'(*b*) Ample protection to secure safety to markers;

'(*c*) To facilitate marking, the markers should be able to see the strike of the bullets on the stop-butt;

'(*d*) The roof of the gallery should slope slightly towards the target so as to avoid, so far as possible, ricochets from the roof on to the target. A layer of earth, free from stones, sand, or tan, lessens the chance of ricochets.

'(*e*) The bottom of the target should be 6 inches clear above the roof of the gallery, so that it may be clearly seen from all firing points.'

The protection of the gallery from direct fire should be arranged with reference to the power of penetration of the bullets, coupled with the diminution of resistance of sods, earth, sand, &c., when their thickness has been diminished by weathering, and with the increased penetrative effect of fire concentrated on a particular spot. A protected store or shed, in which to make and keep targets, should be provided on every full-sized range where firing is constant; it is in some cases desirable that the store and the workshop should be separate buildings. Where, as at Bisley, the butts are on a large scale, it is worth while to have a small tram-line running close in rear of the target frames. By this means targets can be conveyed from and to a central store with the minimum of labour.

The firing points at Bisley are as level as the ground will permit, and are so arranged that the target is visible from them when the competitor is lying very low upon the ground. On this, as on other ranges, it requires some vigilance in the summer to see that long grass or some growth of furze or ferns, &c., does not by degrees create a difficulty.

Underground ranges of different lengths and kinds have before now been constructed to endeavour to meet the requirements of range accommodation in large towns. One was made for a London corps some twelve years ago, and has no doubt been useful for the purpose of instruction. Underground ranges have also been tried in America. They are, however, very expensive to make, except where the excavation already exists. An important matter is the ventilation necessary to carry off the smoke and gases arising from the shooting. If a proper chamber for the purpose, partly shut off, be made close in front of the firing-point, an electric fan or other ventilating contrivance will do what is required, and keep up a supply of fresh air. The illumination is also a difficulty. It is well known that the iris of the eye expands with a decrease of light, and when shooting in artificial light the sights are less well defined than by daylight; while if an orthoptic be used the diminution of light becomes almost too great. The ideal underground range would be such as might be afforded by tunnels at no great depth in the earth, with daylight admitted at both ends. There are sections of the Underground Railway in London which may be taken as illustrating these conditions, but the expense of construction would be quite prohibitive.

Every possible variety of system has been made use of as regards target arrangements. Iron targets were used almost exclusively after the revival of rifle shooting in 1859–60 in this country. But they have gradually been superseded by the foreign system of penetrable targets. This process has been much assisted during the last few years, because the new rifles proved too much for the old targets. At anything like short distances, the high penetrative power of the very hard modern bullets punishes iron, and even steel, targets most severely. Nor is this all. The splash back of the fragments of such bullets after breaking up upon the target is much more erratic, and is found to be much more dangerous than with the old bullets. The iron or steel target was usually made in plates 6 feet high by 2 feet wide, which, resting on a baulk of timber as a foundation, could be raised or lowered alongside each other so as to form a target of any desired size, from 6 feet by 4 feet to 6 feet by 12 feet. They were usually supported by heavy bars of iron hinged upon them at one end, and at the other end thrust into the ground, and much labour was necessary in increasing or diminishing the size of the targets for use at different distances. Larger targets, such as exist upon a few private ranges, 12 feet by 10 feet, or 12 feet by 12 feet, are supported either in the same way, or upon a wall of brick, or of timber, to which the plates are bolted. With iron targets the marking was at first done entirely in what always remained the orthodox military, and, it may be added, inevitably inaccurate fashion, by means of a dummy target of canvas or wood, erected upon poles above the marker's shelter, which was usually 20 to 30 yards from the real target, and well in front of it. In this shelter the marker, though he had a full view of the target, was too far off to be injured by the splashes of lead. He could see every shot as it struck the target, and was in theory able to mark each one of a succession of shots by means of discs representing different values upon the dummy target above his head. If the shot struck the bull's-eye, he would show a white disc upon that part of the black bull's-eye of the dummy which corresponded to the part actually struck. If the shot was a centre, he would mark it with a black disc; and if it were an outer, he would mark it also with a black disc, but in this case would wave the disc wildly to one side before placing it upon the dummy. A red disc was sometimes used to signal the inner. Such a method was very rough and ready, but it was very easy to make mistakes, especially if the marker was trying to be smart, and the indication of the whereabouts of the shot given by the dummy could hardly be an accurate one. There was very likely to be confusion when two or three shots struck, as sometimes they were bound to do, almost exactly in the same place. After twenty or thirty shots it was necessary to cease firing, in order that the target might be repainted, and many accidents have happened from the marker having to expose himself for this purpose. The process of washing out produced a smudgy appearance, as the shooting had to be continued before the paint was dry; whitewash, when still wet, has a very dirty appearance, nor is it easy to discern shots on it. If rain came on, the target was apt to be entirely smudged, and the black of the bull's-eye to trickle across the white. If the downfall were at all heavy, parts of the iron would be washed almost clean, so that it was almost impossible to discern the shots. The system of marking on an overhead dummy at a distance was so unsatisfactory that other means were soon devised. One which worked very well, but had a slight liability to danger, was that of having a mantlet quite close to the target with an iron frame to it to protect the marker from splashes, and a small window of very thick glass through which he could watch the target. There was also a slit cut in the side of the mantlet, which enabled him to thrust out a pole with the marking-disc on the end of it, and with a brush attached to the middle of the disc to paint out each shot as he marked it. The disc, being black on one side and white on the other, had a socket on each side in its centre, into which the brushes were fitted, so that when the white side of the disc was turned towards the firing-point to mark the bull's-eye, the brush projecting against the face of the target was that filled with black paint, and *vice versa*. A small hinged flap or shutter, closed by a spring or weight, was usually the means adopted to protect the marker from splashes which might enter by the opening in the side of the mantlet. Splinters of lead used occasionally to find their way into the mantlet under such arrangements, and a shower of rain might obscure the marker's view of the target through his little window, but, on the whole, the system worked fairly well; and it had this immense advantage, as compared with the marking of the shots upon a dummy, that each shot was painted out as it was marked, and consequently mistakes in marking were likely to be very much fewer. An arrangement on a similar principle, in which the marking was done from a trench below the target, with windows in its roof, was adopted on some ranges.

One favourite device upon ranges fitted with iron targets is that of having a ringing bull's-eye. This is a separate plate, usually of steel, of the precise size of the bull's-eye for the distance in use, which is hung on the face of the target, and projects from it a little way. Sometimes it is suspended from a strip of iron that is hooked on to the top of the target, and hangs down upon its face, and has a projection which engages in a hole near the edge of the bull's-eye; sometimes the bull's-eye has a hole in its centre, through which passes a bolt which secures it to the target. In either case it is essential that the bull's-eye plate should hang clear of the target, so that when struck by a shot its vibration may not be interfered with. It is eminently satisfying when the report of the shot is answered immediately by a loud clang—a sound, if the bull's-eye is well hung, almost like that of a church bell. The shot which misses the bull's-eye is known by the smack with which it strikes upon the iron, or by the dull thud, or, at long ranges, the absence of sound, which denotes its striking earth. The ringing bull's-eye is a great help to the marker, but it will sometimes make a shot difficult for him to see, if it strike on the face of the target close to the edge of the bull's-eye on the side furthest from him, or just over the top, so that the projecting plate intercepts his view. A curious effect, which comes out after some years' use of a ringing bull's-eye, may also be noticed on the larger plates of metal targets: the bull's-eye gradually assumes a convex form, that is, its surface becomes slightly curved, and its edges thrust back from the level of its centre. This is the effect of the hammering it receives from many bullets, each one slightly stretching what may be considered as the skin of the steel plate just at the point at which it hits it. The aggregate effect of this is that the side on which the bullets fall becomes a little larger than the other, and consequently the plate is bowed outwards.

CHAPTER XV

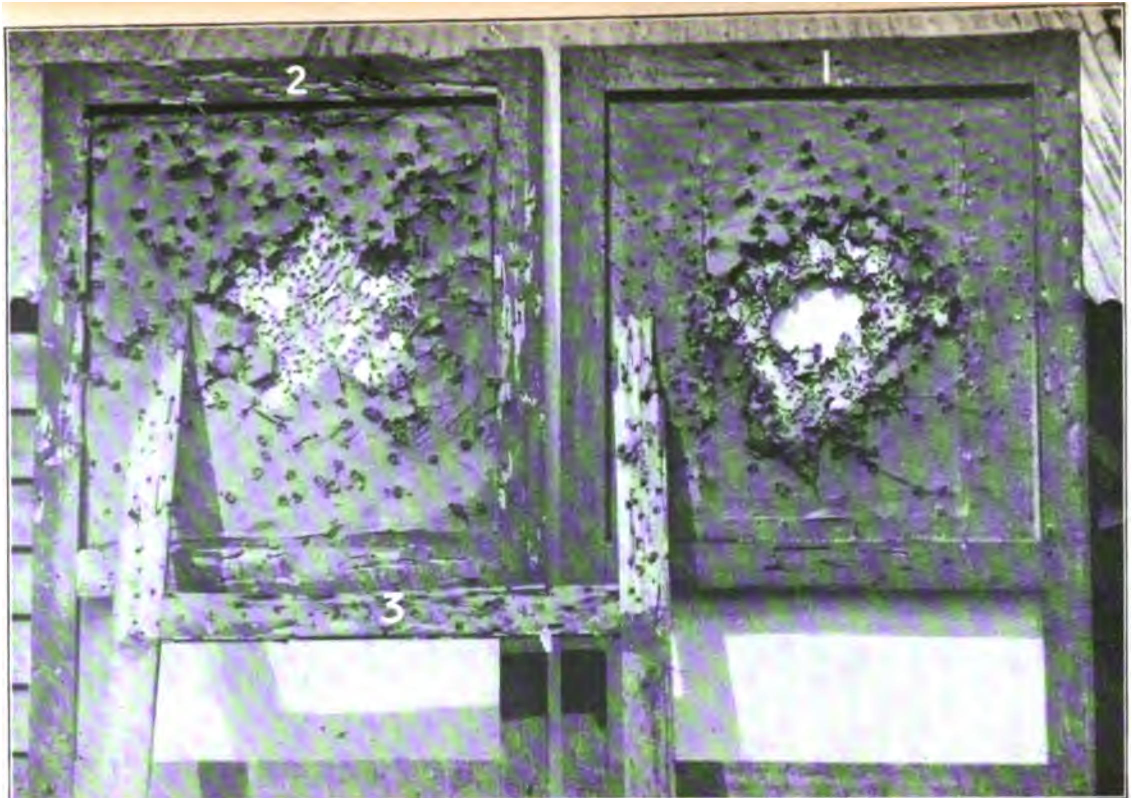
PENETRABLE TARGETS NOW USED—THEIR ENDURANCE—WINDMILL AND JEFFRIES TARGETS—METHOD OF MARKING—FOREIGN RANGE EQUIPMENTS DESCRIBED—PRIMITIVE SWISS RANGES—SOME TARGET SYSTEMS—THE TELEPHONE AND BELL—RANGES FOR PRIVATE PRACTICE—MARKERS AND MARKING—FRAUDULENT MARKING—CHINESE MARKSMANSHIP

WITH the bow and arrow, penetrable targets were naturally used, and in the early days of rifle practice they were not uncommon. They were free from the danger of splashes of lead flying off them. In 'The Rifle, and How to Use it,' 1858, Hans Busk speaks of a target covered with white cotton, at that time issued officially. He says: 'Nothing can be much worse than those issued by the Ordnance Department for the Army; they consist of an iron frame, covered with white cotton. . . . Erected generally on an open ground, with no object behind to detach them from the surrounding scenery, and of so flimsy a texture as to be speedily torn to rags, it soon becomes impossible to observe where they have been hit. Were they made of stout canvas, with cartridge paper pasted over them, and that renewed as required, they would be far better in all respects, and would then last for a long time.'

This is exactly the construction of the modern penetrable targets, which were copied from foreign ones and definitely adopted by the National Rifle Association in 1874, in spite of much heated opposition and protest, and after a great deal of hesitation. The result was entirely successful, and it was found that in rainy weather, in which the marking on iron targets would become almost impossible, canvas targets offered very little difficulty. The *sine quâ non* of penetrable targets for continuous use is that each shot-hole should be patched out as soon as another one is made, and thus all confusion in marking is obviated. The old pattern of canvas target used at Wimbledon at medium and long ranges had an iron frame, the bars of which were bevelled to a knife edge in front, so that the bullet striking them glanced, and went harmlessly into the butt in rear. Targets made in this way were so heavy that in the case of those for long ranges it was necessary to wind them up or down from the trench below by means of a windlass and chain—a very laborious process. Nowadays, it is found far safer, as well as more convenient in manipulation, to have the target made entirely of wood, canvas, or Willesden paper, and other paper, and to fasten it by feet into an iron frame, which is sheltered by a butt or mantlet from the shots.

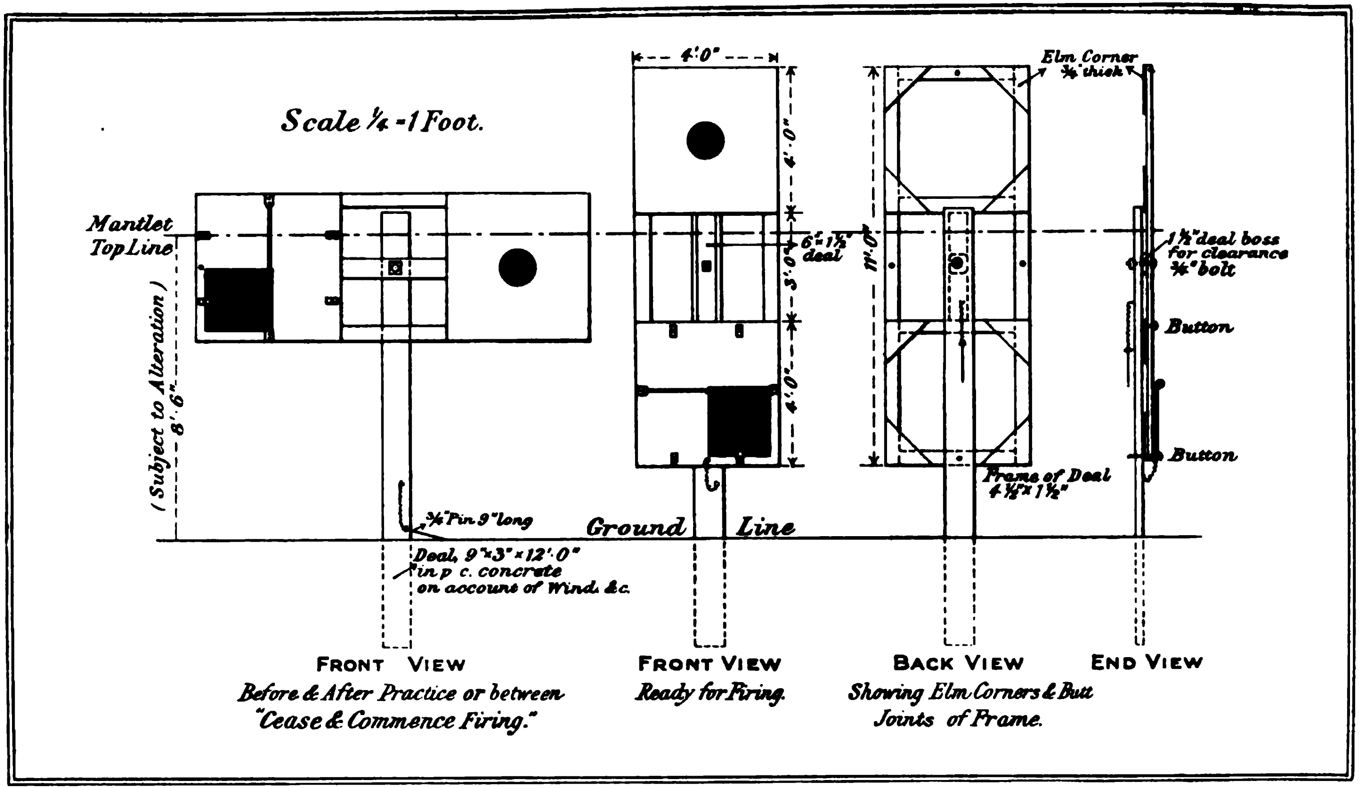
It might well have been thought that where the amount of shooting is considerable, and especially when it is of a high class of accuracy, a penetrable target would be so quickly destroyed as to be of very little use after a few hundred rounds. This is by no means the case, as is shown in Plate XLV, which gives a photograph of the back view of three targets used for 200 yards' shooting at Wimbledon and Bisley for more than twenty years. That numbered 1 shows the effect of a very large number of shots in match shooting and practice. The bull's-eye has been entirely shot away, and almost the whole bulk of the hits is within a space of two feet in diameter in the centre of the target. The target has been re-faced many times with paper, and re-backed at least once with canvas, but the number of shot-holes towards its outer margin is small, and very few bullets have perforated the wooden frame on which the canvas is stretched. No. 2 shows a similar target that has been used for ordinary class-firing and practice. In this, although the middle of the target shows most hits, the shots are far more widely distributed, and the frame has received so many of them as to be hardly fit for further service. No. 3 shows the 'last scene of all that ends this strange eventful history,' when the frame is hardly fit even for firewood, having entirely succumbed to the shooting.

All kinds of systems have been devised for carrying penetrable targets: Most of them seem to have been invented more than once. The windmill system consists of a pivot set horizontally, upon which is arranged a frame carrying two



EFFECT OF FIRE UPON PENETRABLE TARGETS AT BISLEY

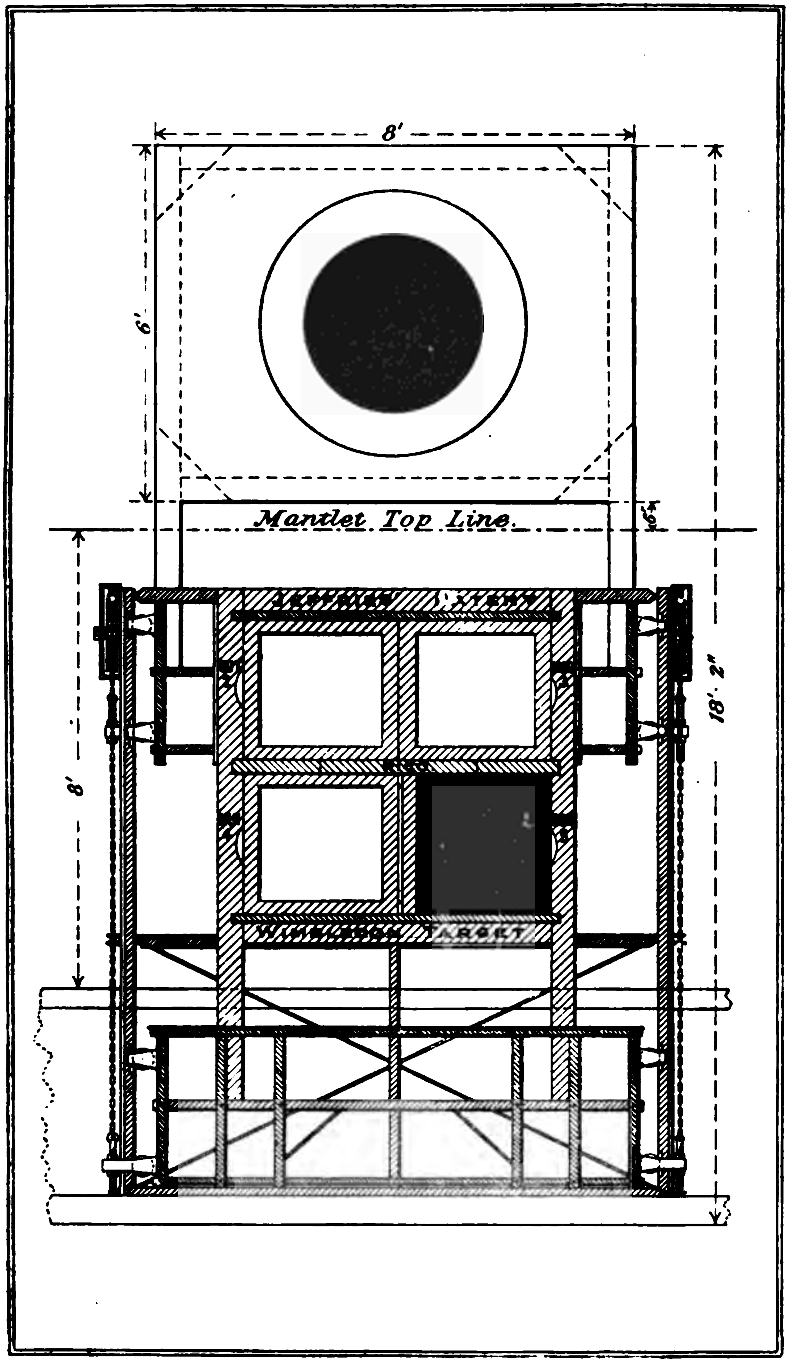
targets, or a target and dummy, one above it and the other below. A simple form of it is shown in Plate XLVI, taken from a newly issued official handbook. A catch holds the target and dummy in place, so that one of them is upright above the mantlet, or trench, in which the apparatus is fitted. When a shot has been fired it is marked on the dummy, the catch is released, and the target swung round until it has come down into the trench, and the dummy has taken its place. The previous shot-hole can then be patched with the little square or round paper patch, which is universally used with penetrable targets, and so the process is continued. This target system has the disadvantage that it requires a clear space for some little distance on each side, as the targets swing round in a vertical plane like the arms of a windmill. It is not well adapted to targets of any great size, as they are heavy to move, and require more space as they are turned round. The target mechanism used at Bisley is almost exactly similar to that made by Jeffries, of Carshalton Road, Sutton, Surrey (Plate XLVII), who owns certain patents connected with it. It represents the gradual improvement effected by the experience of the National Rifle Association on the Swiss balanced target as originally introduced into this country. It has been adopted of late years for many of the modern ranges in use for the military rifle. The principle is very simple. Two iron frames are hung one behind the other by means of a chain at each end, which passes over a pulley, so that when one frame is up as far as the height of the pulleys will allow, the other is down. The frames are fitted with sockets to carry wooden target frames, on which canvas is stretched; these being of equal weight the balance is not disturbed, and it requires no great power to bring either of them to the topmost position from which they are visible to the firer. It is usual to have only one actual target to be shot at, and to balance it by a dummy target, fitted with a black panel, by which the value of the shot is indicated. On the Bisley ranges this panel consists of a square frame of wood covered with painted canvas, and it can be hung in either of the four corners of the dummy, which is otherwise white, according to the value of the shot which it is desired to mark. On a shot striking the target, the panel is hung on the proper part of the dummy to indicate its value. The target is then pulled down into the trench, or behind the mantlet, which shelters the marker. As it comes down the dummy goes up. The marker places in the hole made in the canvas a small disc or square of tin, which he hooks in by a wire, or of cardboard, having a peg fitting the shot-hole. This disc, known as the spotting disc, or in earlier times as the Bland patch (from the name of its inventor), is black on one side and white on the other. If the shot has struck the bull's-eye, it is placed in the hole so as to show its white side, and the shooter, with or without a glass, can see exactly what is the spot that his shot has struck. Then the dummy is lowered, and the target is sent up; when the next shot strikes the target, it is lowered again, the value being signalled in the same way. The spotting-disc is taken out of the first hole and placed in the new hole, and a paper patch, either white or black as may be necessary, is pasted over the first hole. There are thus never more than two holes in the target at a time, and no confusion can arise as to which is the last shot. Of course, markers sometimes make mistakes. The small hole made by modern rifle bullets is easily overlooked, although the click made by the bullet punching its way through the tightly stretched canvas can be plainly heard. If the butt in the line behind the target is watched, the arrival of a shot will be plainly seen owing to the commotion which it makes in the soil, and this will give a general indication as to its whereabouts on the target. A shot may be hard to see owing to the dazzle of light upon the target as the marker looks up at it from below. A Bisley long range target, being 12 feet in width, has a very large surface to be scrutinised. A shot will sometimes strike close against the spotting-disc in the target, or even upon it, so that it is partly concealed by it; or it may be that the paper patches put upon previous shots have partly curled up, and make little projections large enough to conceal a new hole. If rain should come on heavily enough and lasting long enough to wash off some of the old patches, confusion is very probable; but this hardly ever happens. On the whole, the



WINDMILL TARGET, 4 FEET BY 4 FEET, ON SIMPLE MOUNTING, WITH DUMMY.

system works wonderfully well, and is especially adapted for ranges requiring a good deal of accommodation, since the targets can be brought more closely alongside each other than iron targets. The Ninety Butt, as it is called, at Bisley, has ninety targets in a row about a quarter of a mile long, each target being 6 feet square, with 8-foot intervals and a double interval at every tenth target. It does not do to have targets too close together, for fear that a shot intended for one should hit another in a wind in which miscalculation had been made. The long-range butt at Bisley has the targets set with a clear space of 10 feet between each, the targets themselves being 12 feet in width. In Switzerland the targets, about 6 feet square, used up to 300 or 400 metres, are not ordinarily more than 18 inches apart.

There is one general difference between the best equipped ranges in this country and those on the Continent, that with us the targets always stand in the open air, and are not covered in; and the marker's shelter is usually roofed over, but not really enclosed from the weather. On the best equipped Continental club ranges there is a regular building, which covers both the targets and the markers' trench below, from which they are worked. A wall rises behind the targets and forms the back for the building, and there is a pair of folding doors in front of each target so that, when not in use, it can be entirely shut in. The markers have a roomy space below into which they pull down the targets, which are of canvas, in very light wooden frames, the working parts being also of wood—a very good material for the purpose, when, as here, sheltered from the effects of weather. There are usually two targets balanced so that when one has been hit it can be pulled down and the value and position of the shot indicated by a coloured disc upon the other, which is at once ready to be shot at. The shot-hole in the first is meanwhile patched over. This method of marking is quicker than signalling with a dummy. It is less visible at long ranges, and does not admit of the firer seeing the exact position of his shot. Each marker has close at his back an electric bell connected with the firing-point, and on a shot being fired at the target the bell is rung to warn the marker that there is a



JEFFRIES TARGET, 6 FEET BY 8 FEET, WITH DUMMY shot to be signalled. By this means the certainty is gained that a shot is not overlooked from any inattention on the part of the marker. The effect of having the targets set back under a roof, and with something of a partition between them, is to diminish very much the amount of light they receive; and they become liable to be in shadow when their surroundings are in full sunshine, or to be partly in sunshine and partly in shadow, which is even worse. Under a clouded sky, too, they are badly lit, but some modification of these effects is produced if the roof above the targets is partly filled with glass. Still, the illumination is never so perfect or satisfactory as with targets exposed under the open sky. There is often a large store-shed for the targets which communicates with the marker's trench, and on the same level with it, so that alterations of targets, &c., can be made without stopping the firing. At such ranges as these the firing points are most elaborately equipped. Not only are the actual stalls, as we may call them, from which the firing is done, and where the register keepers sit, partitioned off and roofed in, but they are often only the front line of a large building which contains plenty of space behind them, as well as the offices of the club, armouries, refreshment bars, &c., &c. The new ranges at Albisgütli near Zürich, belonging to the Schützengesellschaft der Stadt Zürich, have a fine, permanent building, with ample accommodation of this kind, in which there are firing points for 68 targets, that is, 53 at 300 metres, and 15 at 400 metres, as well as a dozen revolver targets. The division between the shooting stalls is effected here, and in some other ranges, not by boarded screens, which increase the reverberation of the report, but by canvas hangings, which help to deaden it. An underground passage extends from the building to the targets so that access to them is possible without stopping the firing. To give some idea of the popularity of the shooting at Zürich, and in Switzerland generally, it may be mentioned that these ranges, which are situated on very high ground, and command a magnificent view overlooking the Alps, have near by a very large and handsome refreshment building, where the wants of several thousand persons can be provided for at once. There is not only one very large dining hall, with some smaller rooms, but a high covered place, in which some 1,500 people can be accommodated for dinner. There are large cellars attached to the building, well stocked with great butts of wine belonging to the club. This beautiful and convenient place is the favourite resort of the population of Zürich on a Sunday afternoon in the spring and summer months when the shooting is going on. The range of the principal club at Geneva has similar accommodation at the firing-points, and the same is the case on a less ambitious scale in many other places in Switzerland and the Tyrol.

In this country we have declined to confine ourselves to the limitations imposed by covered-in firing-points. The fact that they are not considered suited for military practice is attested by the use on the Continent for the soldiers' instruction and training of open firing-points. In the most modern and best equipped of these the marking and target arrangements are very similar to those which obtain at Bisley. The targets are fitted to iron frames which are hung so as to balance each other, while a series of firing-points allows of their being fired at at different distances, or by troops advancing in skirmishing order. Where, as is not infrequently the case abroad, a background of mountain precludes all question of danger to the public from the bullets, it is sometimes found worth while to have a series of trenches at different distances one behind the other, so that the shooter, without changing his position, can fire at either of two or three distances.

It has been already said that in rifle ranges every degree of elaboration or simplicity is to be found. We have mentioned one or two of the large ranges belonging to wealthy clubs in Switzerland. But in the smallest places no such elaborations are to be found. The range is often a piece of ground regularly used for the purpose, but the arrangements both at the firing-point and the targets are frequently of the most temporary character. The target installation may consist of a few rough frames of larch or fir poles, composed of two uprights and two cross-pieces nailed together, which are fixed into the ground at the beginning of the shooting season, and on which canvas targets are hung when firing is to take place. Or, perhaps, a still lighter framework, sufficiently strong for the target to be temporarily stretched upon it, is taken down to the range and set up at the time of firing. Figure targets of canvas and cardboard have one light wooden cross-piece at the shoulders, and another, perhaps, below the waist, and a flat upright ending in a point which is stuck into the ground. The marker has, it may be, a little wooden hut near by, in which he keeps his gear, and against which a mound or a big stone gives him a safe place of retirement while firing is in progress. Or he may merely bring all his necessaries with him for the shooting, and retire behind the natural shoulder of some hillock during the firing. In such circumstances it is, of course, impossible to mark every shot as it is fired. A series of shots is fired at each target by a corresponding number of shooters, and when firing has ceased a horn is blown to call the marker, who signals the number of the hits and patches the targets. In Switzerland, where every village is bound by law to provide a range of some kind, this rather primitive method is not uncommon. It is not always, apparently, that the marker finds it necessary to retire behind shelter at all during the firing. There is said to be one Swiss village where he sits at a table with his wife, some twenty or thirty yards to one side of the target, where firing is going on, in full view of the shooters, and eats his dinner, or drinks his glass of wine, very happily, in the intervals of the marking; the story is credible enough to those who have seen how free from wild shots is the practice on an ordinary Swiss range.

It is perfectly clear that on a range to be much used a complete installation of targets with ample sheltered room for the markers is very desirable in the interests of safety. At Wimbledon in old days, and on the military ranges on which iron targets were used, there were very rarely accidents; but with a proper system (such as is now generally adopted) of marking in sheltered trenches upon canvas targets, accidents to markers should be impossible. On ground on which it is not convenient to form a deep trench, the same purpose of sheltering the marker may be obtained by a butt or mantlet raised above the level of the ground. In such a case it may be inconvenient to have the target above this shelter, as then it is so high as to require, possibly, a higher altitude of butt behind it than is easily provided. To meet this difficulty various devices have been arranged for running the target in and out sideways from behind the butt. This, though it entails rather more labour upon the marker than the use of balanced targets, answers well enough. The detail of such an arrangement is easy enough to devise. The target frame is usually upon a little low truck, which runs to and fro upon rails, and is sheltered by a very low bank of earth. Some arrangement of windlass or wheel draws it in or out by a chain or wire rope. There was shown two or three years ago at Bisley an arrangement called a gate target, in which the target was on a frame hinged close to the corner of the mantlet, as a gate might be, and could be swung out so as to come into position across the line of fire. After a shot had been fired, the gate was swung back a little more than a quarter circle, so that it was almost parallel with the range, and entirely concealed behind the marker's mantlet. The objection (and it seems a real one) to this arrangement is that to paste up a shot-hole on the further edge of the target, or to hang a patch on it, the marker has to be so far behind his shelter that he would not be covered from a ricochet fired at an adjoining target, and taking a low diagonal course. The writer thinks the balanced targets certainly preferable. There are two or three systems, such as Ralston's and Spencer's, which are ingenious, and have very good points. On the whole the simpler the mechanism is the better. There are many different mechanical arrangements for balanced targets which work excellently for demonstration, but are less suited for continuous work and the inevitable hard treatment of actual use than simpler and less attractive devices. The question which system to adopt for a target which has to be much used is one to be decided by individual choice and fancy, but where the circumstances allow the writer does not think any other system better than the balanced frame on the window-sash principle, in use at Bisley and elsewhere.

An ingenious means, invented some years ago, for taking Mahomet to the mountain, instead of the mountain to Mahomet, that is, the marker and his shelter to the target, instead of the target to him, had some success. The marker's mantlet was constructed of steel as thin as was compatible with its being bullet-proof, and was set on small flanged wheels, so that it could move upon rails to or from the target, the marker pushing it with him as he moved. It was suitable enough for use with the canvas target, and enabled the marker to reach the actual spot struck by the shot without exposing himself, the wheels of the mantlet and his own feet being protected by a low bank of earth. Although the mantlet was necessarily of considerable weight, it was not very hard to push, but the labour involved in a long afternoon's work was no doubt considerable. This invention came rather too late. With the old soft lead bullet it was a practical thing, but now that the penetration of the rifle is so much greater than it used to be, it is difficult to reduce the weight sufficiently for it to be really mobile. With this system of marking, the shots are signalled by a disc at the back of the mantlet, which is attached to a pivot in its centre, and can be brought into either corner of the square formed by the upper part of the mantlet by turning a handle within. This principle of signalling is sometimes adopted for fixed mantlets where they are backed with steel and not with earth, and is expeditious; for the marker moves the handle to the proper point when he has seen the shot strike, and the disc remains in position while he is pasting out the previous shot. This method of marking is, of course, only applicable to above-ground mantlets, of which the back is plainly visible.

For limited use, as of a single individual practising privately, much simpler arrangements will suffice. Sir Henry Halford shot for thirty-five years on his range at Wistow at an iron target with a marker's shelter a little way off. No dummy target at all was used, but after each shot the marker walked out from his shelter, and held for a few seconds a wooden disc about 8 inches in diameter attached to a handle some two feet long, so that its centre was on the actual point struck by the shot. This was ensured by having a hole in the middle of the disc, which was put exactly upon the shot-mark. The shooter looking through a telescope could thus spot the shot exactly, and the marker then painted it out and retired again to his shelter. This is a very simple and safe arrangement where there is no question of hurrying the shooting, or of more than one target, or of the atmosphere being thick. In clear weather a flag can be shown at the firing-point, and another at the target, if it is desired to cease firing. But the great modern safeguard is the telephone, which should always be installed if possible in any range exceeding 100 yards in length. Even the telephone requires care in use. Sir Henry Halford on one occasion—it was not a very clear day—was about to begin shooting at 1,000 yards on his range, and thinking that the marker must now be ready for him to begin, asked him through the telephone, 'Are you all right?' The marker replied, 'All right, sir, in a minute,' but unluckily Sir Henry took 'All right, sir,' instead of the whole sentence, and removed the telephone from his ear. He lay down and fired his shot, and on looking through the telescope to see where it had hit was horrified to see the marker with a perfectly white face staggering away towards his shelter. He was intensely alarmed, and in a moment there came a ring at the telephone. 'What has happened? Are you badly hurt?' 'No, sir, I am not hurt, but I had a bucket of whitewash between my legs painting the target, and you put a bullet into it, and splashed it all up in my face.' That was a narrow escape, and it shows how easily a trifling want of care will lead to danger. It is the common experience with markers that at first they are so nervous that they hardly dare come out from the shelter, even after the 'Cease fire' is clearly signalled; then for a time they are properly and reasonably cautious; but as the habit grows upon them, and they find they are not in danger from the firing, they are apt to become foolhardy. It is then that accidents happen.

But there is no reason why there should be accidents if proper precautions are taken. In default of the telephone, a most useful thing is an electric bell, by which signals can be exchanged, a single ring for 'Cease fire,' two rings for

'All clear' or 'Commence,' three rings for 'Re-signal last shot,' &c. For ranges on which the marker comes out to mark on the target a very good appliance is sometimes used to obscure the bull's-eye as a danger signal. From the marker's shelter there runs a long pole laid upon the ground, and pivoted at each end, with a transverse handle sticking out from it at the near end, so that the marker can give it a quarter of a turn without exposing himself. The further end of it is in a line with the middle of the target, and to this is attached a square shutter, painted white, and large enough to hide the bull's-eye when raised erect. This ordinarily lies flat on the ground, and out of sight, but if the pole be turned the quarter turn the shutter stands up and the bull's-eye is obscured. Devices of this kind may easily be adapted to circumstances. There is much to be said for the Swiss custom, several centuries old, of the marker wearing a bright red blouse, which constitutes him in himself a danger signal when in view, and it would be well if this were made a part of the ordinary equipment of markers in this country. For special circumstances special targets may be arranged. In practising at 2,000 yards with a heavy rifle in 1864–5, Sir Henry Halford and Mr. Metford had a target 12 feet square set up, made of poplar planks, and painted white. The marker had a little ladder, by means of which he could reach any part of the target, and with a supply of corks plug up each shot-hole, after signalling the hit. This was a target only needed for a few weeks or months. It is no bad arrangement to have the marker in a pit close under the target, with a little hut, in which he can shut himself, having a good door to it. He can then come out and signal the shots from below with a disc, and paint them out with a brush attached to it. This, perhaps, is quicker than when he has to walk from a shelter on the same level at a little distance. An iron target is all the better for having two or three good coats of oil paint upon it, black for the bull's-eye, and white for the rest of the target, and for having divisions marked on it in the same way. The surface of the iron is preserved, as the paint remains except exactly where the bullets strike. It is, of course, painted up with whitewash and lampblack in the ordinary way. A little size in these paints is an important addition, since it helps them to stick and to resist wet.

It is worth mentioning that a small mirror, put up to one side of the target, in such a position that the marker can see the firing-point reflected in it, is a great convenience if there is no telephone. But it is as well not to allow it during prize firing.

Sometimes, especially at the beginning of a rifle meeting with untrained markers, who have not yet become accustomed to the work, a shot is erroneously marked or a hit is overlooked, but in the large majority of cases when there is any doubt as to a hit or the value of a shot, the competitor sees for half a minute or so a blank dummy, indicating that the target is being examined. The holes made by modern bullets are so small that it is wonderful that mistakes in marking are not more frequent than they actually are. Before the introduction of the modern rifles the bullet-hole was large enough to be conspicuous upon the canvas target. At Bisley the actual butt is set back a considerable distance behind the line of the targets, in order that no discomfort to the markers or obscurity of the target to the firer may arise from the dust caused by the bullets, and there is not only a tram line, but space for a cart track between the targets and the butt. It is a favourite dodge with the markers to place a piece of paper or some other object on the spot which a bullet would hit after passing through the middle of the bull's-eye: it can then be seen quickly enough, when a shot strikes the bank, how near the centre, and in what part of the target, the mark of it should be looked for. The dummy of the Wimbledon and Bisley targets used to be covered with a sheet of canvas painted white, but the markers who watched the bank began by cutting holes to make small windows in the canvas of the dummy, and it seems better to abolish the canvas, and merely to cover the dummy with wire-netting painted white, which offers no obstruction to the sight. The exertion so continually undergone in former years of standing for hours at a time in a hot trench, with the head raised, and the eyes fixed upon a dazzling white target almost vertically overhead, must have been a great trial to the markers, and it is satisfactory that much of this particular discomfort can now be avoided. Markers require careful supervision. Like all other human beings, they are liable to err, sometimes through carelessness, sometimes knowingly, out of kindliness, or a desire for gain or advantage in some form. The writer remembers once practising on a country range and making a satisfactory score on an iron target; on going up to the butt at once he discovered that several shots which had been marked bull's-eyes were obviously inners. On iron targets it is usually possible with a good glass to see each shot before it is marked, and in this way the marking can be closely supervised. With canvas targets the bullet-holes are practically not visible at 500 yards and beyond, except under good conditions and with a powerful glass. The scandals at Wimbledon in 1881 show that at a large open meeting there are always a certain number of men who are ready to take advantage of any chance of a profitable swindle. It was not so very difficult when a man knew days beforehand exactly to which target he was detailed at a particular hour, and could come across and make friends with a venial sergeant. The latter could almost certainly work matters so that he should be in the butt himself that day, and be able to superintend the marking of that particular target. A preconcerted signal could even be arranged to guard against mistakes, such as standing up and exhibiting a large expanse of white waistcoat just before the firing, if the marker had the means of seeing the firing-point in a mirror, or when coming out to clean the target; firing the first shot at the number-board above the target; or even with coloured paint on the bullet, which left a mark as it penetrated the canvas. Such devices as these are practicable enough if opportunity is given. The present system of squadding adopted at Bisley, by which a man does not know beforehand at which target he is to shoot, while the markers cannot see the firing-point, has put, it is believed, an effectual stop to such profitable but iniquitous conspiracies. The subject is unsavoury, and need only be touched on lightly, but it shows the need of good management, and the importance of never giving an opening for sharp practice. Of the swindling which arises from a desire to please, we can hardly give a better instance than one which occurred a very few years ago in China. An English admiral landed to attend an inspection of the training school for Chinese officers by the Viceroy, Li Hung Chang. Part of the inspection consisted of a visit to the rifle ranges at which the young officers were paraded to show their skill. The admiral observed that with an extraordinary regularity, amounting, in fact, to monotony, a bull's-eye was marked for every shot fired. He remarked on this to the European instructor with whom he was standing. The latter admitted that such incorrect marking was an absurdity, but declared that it would be considered an insult to the dignity of so great a man as the Viceroy if any shot fired on the occasion of his visit were not a bull's-eye.

CHAPTER XVI

METHODS OF COMPARING MERIT OF GROUPS OF SHOTS—TARGETS WITH CIRCULAR RINGS—THE ELEMENT OF LUCK IN SHOOTING—CARTON SHOOTING—POOL SHOOTING—SIZE OF CENTRALS—OVAL TARGET DIVISIONS—BISLEY SIGNALS FOR VALUES OF SHOTS—ELECTRIC TARGETS—RICOCHETS—PARTICULARS OF NATIONAL RIFLE ASSOCIATION AND OTHER TARGETS

In testing the accuracy of rifles or ammunition, without respect to the correctness of the sighting, the method is to fire a series of shots with exactly similar aim. Each of these is then measured from any horizontal line drawn above or below them. The average distance of all the shots from this line is found, and a horizontal line drawn to represent it. Similarly, the shots are measured from a vertical line outside the group, and a vertical line drawn which represents their average distance from it. The intersection of this line and the horizontal line marks the 'point of mean impact.' Each shot is measured separately from it, and their total or average deviation represents the figure of merit of the whole group.

The method of marking and scoring shots varies a good deal in different countries, and admits of many modifications. It is commonly accepted that the most satisfactory system of marking is to measure the distance of each shot from the absolute centre of the target, and by adding up the total of the deviations of every shot in the series fired to arrive at a definite figure of merit. This method, however, gives no preference to a close group not actually on the central point aimed at, as against shots scattered round it. It is in vogue in America in reckoning the merit of very fine diagrams made under perfect conditions from a rest, and is called string measurement. To this kind of leisurely shooting it is suitable enough. In Switzerland and elsewhere upon the Continent a near approach to this system of marking is practised in some classes of competitions. One target, which is 1 metre in diameter, is subdivided into very narrow rings a centimetre or half a centimetre wide, and numbered from 1 to 50 or 100, from the outer ring to the centre of the target. By signalling the number of the innermost ring touched by the shot, which can be done at 300 or 400 metres by exhibiting large figures placed in a panel, and hoisted up, the score is made to correspond closely with the actual measurement of each shot from the centre. The same result is sometimes arrived at by measuring the distance of each shot from the centre of the target with a tape, or with a brass rod having on it a well-made vernier scale which carries a point that can be adjusted precisely to the middle of the target, a fixed peg in the other end of the rod being fitted into the hole made by the bullet. This gives a reading of any required degree of accuracy. For scoring in this way circumstances must allow of the marker not being hurried, and of his being extremely careful and trustworthy. It is, in fact, necessary that he should be skilled at this particular employment, a condition which at large rifle meetings in this country it is almost impossible for markers to fulfil. Shooting at a target when the measurement of the shot is so very exact demands that the range should not be very long, and that the firer and the rifle should have every advantage of protection from weather, and of refinement of sights, and delicacy of trigger. When we remember that no rifle can be depended upon to shoot within 2 or 3 inches in ordinary weather at 200 yards, it is evident that nothing is gained by multiplying the number of circles upon a target so that they become quite disproportionate to the size of the group that the rifle will make. Nothing is gained, that is, as regards classifying the skill of the shooter, and almost nothing as regards gauging the capacity of the rifle, while the process of marking requires much more skill than it would with fewer rings and simpler values. At the International match at The Hague in 1899, the target used was one divided into numerous small circles (see p. 482), and at a meeting of the delegates representing the countries taking part in the match, one of the French representatives proposed that in future matches a target should be used having much wider divisions, on the ground that the small divisions were out of proportion to the accuracy of the rifle at 300 metres. This is a perfectly sound argument. It must be remembered, on the other hand, that subdivision into smaller circles accentuates an element, never absent from rifle-shooting, and depending on causes beyond the capacity of either the rifle or the man, which we call luck. As we find from the earliest days of Swiss shooting that the championship was awarded to the man whose shot was most precisely in the centre of the target, and as in Fenimore Cooper's novels, to drive the nail at 100 yards is represented to be the last test of skill, so has there always been a happy disposition to ascribe successes of this kind directly to the skill of the shooter. This very fortunate element is not one to be ignored, for not only does it appeal strongly to the imagination to think that a man is skilful enough to perform such a feat, but it will suddenly raise to the pinnacle of success and satisfaction some marksman of no special merit beyond this, that the gods have favoured him. It is not suggested, of course, that the most skilful shot, armed with the very best rifle, will not have appreciably more chance of making an absolutely central shot than one less skilful, with a less good weapon; but he, too, will require luck if he is to stand first in such a contest. It is well frankly to acknowledge the interest which is created when skill does not have things entirely its own way. A Swiss marksman, so long ago as 1863, said to a member of the Council of the National Rifle Association: 'Your English system will make a certain number of first-rate shots, but it will never, like ours, create a nation of riflemen; it is the element of chance which enters so largely into ours that takes men to the targets.' It is perfectly true that if skill were the only thing that told, it would be possible to know beforehand almost exactly the relative merits of different competitors, and the young shot might well despair of ever getting a place in competition with them. A slight tincture of chance, even when it does not amount to gambling, certainly has an immense attraction for human minds, as witness the popularity of 'egg pool' at Bisley in 1899, when a prize was given for hitting at 500 yards a 2-inch circle marked on a piece of cardboard hung in the middle of the bull's-eye, a thing which skill alone could not certainly accomplish. It may well be doubted whether the Queen's prize was not more attractive to competitors generally in the days when anyone who could pass through the ordeal of the first stage had a fair start with his neighbours at the long ranges in shooting for the much coveted distinction. The Queen's 60 (originally 40) was expanded to the Queen's 100, and the consequence of piling up the totals made at all the ranges, and deciding the prize by the aggregate, has been that the man who is low down in the 100 feels that he has almost no chance at all of carrying off the blue ribbon of rifle shooting. The competition is much more of a real championship than it used to be, but it has lost something in attractiveness for the man who is not yet certain of being able to hold his own in a competition extending over several days with the pick of our Volunteer marksmen.

At Wimbledon many years ago great interest used to be excited by a form of competition imported from Switzerland, and known as Carton shooting. A circular piece of thick cardboard coloured black was hung in the middle of the bull's-eye. It varied in size according to the range. Prizes were given for the shots nearest the centre of the carton at each distance during the whole meeting. Each carton was numbered, and the shooter's name was entered against a corresponding number in the register. After the meeting was over the cartons were measured up. There was no difficulty in rejecting a very large number in which the carton had been pierced by a shot not far from the edge, but among the central shots the differences were usually very fine, and required an extremely accurate machine to measure them. It would happen sometimes that some schoolboy, paying his 6*d.* for a single shot at a carton target, would carry off one of the substantial money prizes, running up to 25*l.*, which were given for the most central shots, while a man who had invested a certain sum of money in carton shooting, and persevered at it, would be unlucky enough not to have a single shot near enough to the centre to win him a prize. To meet his case money prizes of a certain value were given to those who had made the largest number of cartons at any particular distance. The competition for this used to be very keen. Carton shooting was decidedly very fluky work. Mr. Henry Whitehead recounts that on one occasion at Wimbledon, when he had taken some friends to the 600 yards firing-point to show them what carton shooting was like, he made five-and-twenty consecutive bull's-eyes without once touching the actual disc of the carton. The bull's-eye at this distance was 2 feet in diameter, and the carton about 1 foot. To give an opposite instance, Mr. Martin Smith many years ago undertook to break a dinner plate in 15 shots at 1,000 yards, and succeeded in doing so.

An attempt was made to revive carton shooting at Bisley in 1890, but it was not very successful, and nothing of the kind now appears in the National Rifle Association programme book. The conditions have changed. The programme of shooting at the National Rifle Association meetings is far more crowded than it used to be, so that the earnest shooter has little leisure to spend in odd competitions. There is in the present days of the Volunteer movement a much smaller proportion of men who can afford to invest a few pounds on the off-chance of getting a big haul than there used to be.

Shooting at pool still survives, and is very popular. The shooter pays a shilling or thereabouts for each shot. The total amount of the entrance fees, *minus* a deduction for expenses, is divided among the successful competitors in shares proportionate to the number of successful shots which they make. Formerly each bull's-eye made entitled the shooter to participate in the division, but the improvement in rifles has made it necessary to introduce a central bull's-eye, defined by a white circle, so that a man may hit the black without necessarily obtaining any return. Pool shooting is fairly safe work for a skilful shot; he may invest as much or as little as he pleases, and in any case his return is likely to be proportionate to his investment. Large profits are not to be expected, but steady winnings may be made by the careful man. The value of pool bull's-eye tickets of course fluctuates with the weather, and they are worth more in difficult times, since fewer are obtained in proportion to the whole number of shots fired. Of the whole amount received as entrance money for pool 25 per cent. is usually deducted for expenses before division.

The pool target is similar to the ordinary target for each distance, and shots are marked in the same way, except that to mark the inner bull's-eye within the central circle the bull's-eye panel is sent up with a white ring, visible at the firing-point, hung upon it.

The sizes of the central within the bull's-eye at the several distances were, in 1901 :—at 200 yards, 4 inches diameter; at 500 and 600 yards, 12 inches diameter; and at 800 to 1,100 yards, 21 inches diameter. The principle hitherto adopted has been that they should have about one-third the area of the whole bull's-eye.

In 1885 targets with elliptical bull's-eyes were adopted for the military practice of the American army, the bull's-eye being greater in height than in breadth, and the circles of the inner and magpie made to correspond. These were designed by Captain Blunt, Inspector of Rifle Practice at the headquarters of the American army. Diagrams of these targets, reproduced from a book published by Captain Blunt, may be found in Gould's 'Modern American Rifles.' For the third-class targets the bull's-eye was 10 inches high by 8 inches wide; for the second-class targets, 24 inches high by 18 inches wide; and for the long ranges, 45 inches high by 32 inches wide. These elliptical divisions serve the purpose of making a nearer approximation than circles to the shape of a man's upright figure, at which, in theory, practice in the field will be directed. They also represent better than circular divisions the normal shape of the group made by a rifle with indifferent ammunition, and Captain Blunt considered them to represent the shooting of the Springfield rifle. The elliptical shape has the great disadvantage of being much more difficult than the circular for the marker to draw accurately. It was never popular, the mass of shooters preferring the simpler form, to which they were more accustomed, and over which the elliptical bull's-eye offers no real advantages.

For many years now circular bull's-eyes and circular target divisions have been the rule in this country. They are not only theoretically fairer than square ones, but they are practically easier to make. The National Rifle Association adopted square divisions from 1862 to 1874, but since then they have never been revived.

It is puzzling to a visitor at Bisley to see the target go down, and a curious dummy appear in place of it, with a black square in one of its corners; but the appearance of the dummy (fig. 85) is full of significance to the initiated. If the black square is in the top corner on the left-hand side as you look towards it, the hit is an outer, value 2 points; if it is in

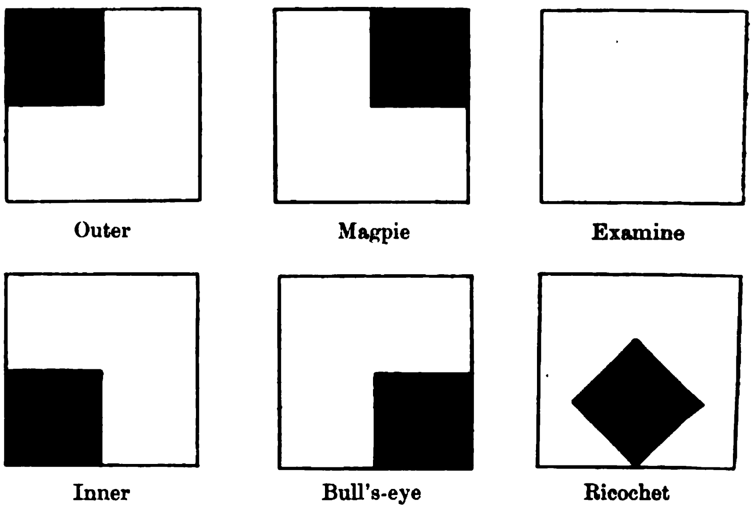


FIG. 85

the top right-hand corner, a magpie, value 3 points; if in the left bottom corner, an inner, value 4 points; if in the right bottom corner, a bull's-eye, value 5 points. If a ricochet has to be signalled, a square panel is hung with one corner uppermost, like the old-fashioned hatchment, a little below the centre of the target. If it is desired to lower the target for the purpose of examining it, the black panel is not hung on to the dummy, which appears blank. The attachment of the panel to the dummy is very simple: it has light iron hooks in convenient places which fit on little rails projecting an inch or two from the surface of the dummy.

The old mechanism for lowering and raising the heavier targets by means of a winch was very slow, and, like the system of marking the value and position of the shot by a large coloured disc hung upon the wire netting with which the face of the dummy was covered, has long been superseded by simpler methods.

There is nothing new in the notion that a target might be constructed which should signal the hits automatically at the firing-point, the different divisions of the target being represented by different plates, which complete an electric circuit when moved or jarred by the blow of the bullet. In 1882 such a target, on a miniature scale, invented by M. Boivin, was shown at Wimbledon. It was shot at only 10 yards away with saloon rifles, and, on the whole, did not do badly. In 1884 a third-class target on similar principles was exhibited at Wimbledon, and was fired at a good deal. This target was divided into forty-eight compartments, and, on one of these being hit, a number corresponding to it was automatically shown on a dummy at the firing-point. The chief difficulty with such targets has always been that the fragments of lead from the broken-up bullets accumulate and tend to jam the plates so that they cannot move freely the small distance required to make the contact and signal the shot when struck. A minor drawback is that any considerable number of shots remove the colouring and obscure the target, so that it has to be occasionally painted, and thus the services of a marker cannot be altogether dispensed with. Nor is the position of the hit usually shown. The very great penetration of modern bullets has, since 1884, made fresh difficulties in the application of this principle.

With ordinary targets the difference in appearance between a ricochet shot and a direct hit is not always obvious. If the bullet happen to penetrate the target point foremost after glancing off the ground, it is impossible to distinguish the hit from one made directly, and the difficulty is all the greater because the holes made by small, elongated bullets are by no means always round at long ranges, so that, even when every care is taken, mistakes will still be made. The writer recollects, at an important match some years ago, watching with a powerful telescope the first shots at 1,000 yards fired by a well-known marksman. His first bullet was quite clearly seen to raise a cloud of dust close under the target. It had evidently struck short, but a benevolent marker, who very possibly had no means of knowing that the target had been missed, marked a bull's-eye. No doubt the shot had penetrated it after striking the ground. The rifleman, not unaware of what must have happened, raised his sight, and fired again. Again a cloud of dust arose in front of the target, and again the marker, all unwitting, marked him a bull's-eye under precisely the same circumstances. His third shot was a fair bull's-eye, and luckily the result of the competition was in no way affected by the mistake, which it would have been hard to prove officially, since the marker obviously had not discovered it; while the register-keeper, unless he chanced to be keeping a sharp look-out at the moment through his telescope, could have no means of knowing what had happened. The writer has seen, in counting the hits on a canvas target after field firing, two hits given as the result of one shot. A bullet had struck the ground in front of the target; the leaden core had escaped from its nickel jacket, and had penetrated the target in one place, while the jacket had made a larger hole four or five inches from it. On the general question of counting ricochets as hits the writer holds a strong opinion that it should not be done in any circumstances. The value of ricochet fire was considerable in the days of smooth bores, firing round bullets, for the shot after striking went on more or less in the same line, and did not rise very high. At the siege of Mafeking we are told that the round shot of Baden Powell's smooth-bore gun went skipping along for all the world like a cricket ball. Even with such a rifle as the Snider, ricochets were to some extent effective; but with modern weapons this can hardly be said to be the case. The long bullet penetrates where a bullet of larger surface might glance, and its light weight immensely decreases its effect when it has lost velocity from a graze. The effect of ricochets is absolutely a matter of chance, and depends upon the accident of the ground. It is impossible in such competitions as those of the Field Firing Association, where the shooting is done under similar conditions by teams on their own local ranges, to let ricochets count, if only for the reason that the probability of ricochets will be quite different on different ranges. Where, as at Bisley, targets are protected by a high bank, the only ricochets which can strike them are those which graze the top of the bank, or those which strike the ground a long way in front of the bank, and ricochet over it. Much the larger proportion of the shots that strike low strike the face of the bank, and cannot possibly hit the target. The softness of the soil, the accident of there being stones, the shape of the ground, all will affect the question; and if the aim of the shooter is, as it should be, to strike the centre of his object, or, at all events, to group his series of shots as near as possible to that centre, it is quite inadmissible to teach him systematically to fire low, or to allow a shot that, so far as his aim goes, has fairly missed the object to count as a hit.

A table is appended of the targets in use at Bisley for the different distances, with diagrams of those used for the Service and Match rifles:—

Bisley Targets. For Military and Match Rifles.

Divisions	Value	200 yards			500 and 600 yards		800 to 1,100 yards
		1899	1900*	1901	1900 and previous years	1901	—
		Inches diameter	Inches diameter	Inches diameter	Inches diameter	Inches diameter	Inches diameter
Bull's-eye	Counting 5 points	8	12	7	24	20	36
Inner	4 „	20	24	14	36	30	54
Magpie	3 „	32	36	21	48	40	Inches square 72
Outer	2 „	remainder of a target 4 feet square			remainder of a target 6 feet square		remainder of a target 12 feet by 6 feet

* This target was adopted for the standing position, and is still used in the competitions fired in that position at 200 yards.

The targets used in 1901 are illustrated in figs. 86, 87, 88. The alterations made to the targets for the shorter distances became necessary owing to the very long strings of bull's-eyes which could be made with the ·303 rifle upon the targets previously used, especially at 200 and 500 yards, in the lying-down positions. The reduction in size of the bull's-eye and other divisions has done little to reduce the scores made. In 1901 many scores within two or three points of

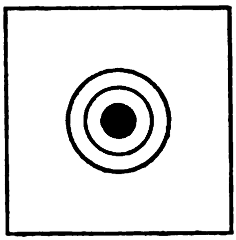


FIG. 86

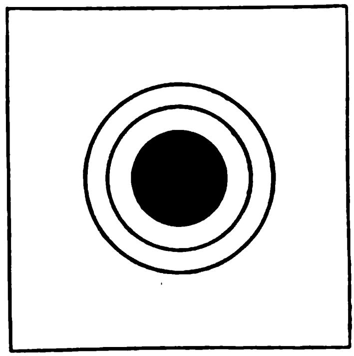


FIG. 87

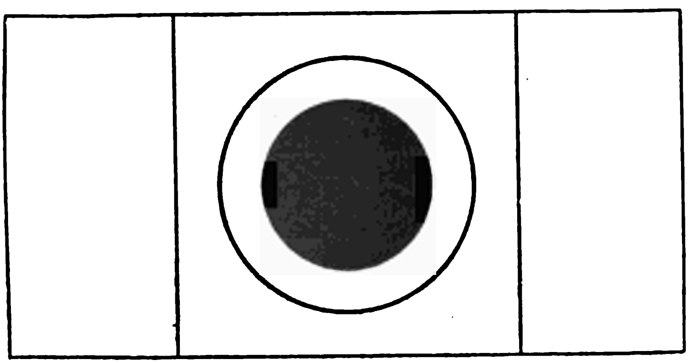


FIG. 88

the highest possible failed to take prizes in competitions at a single distance, and under the rather arbitrary rules for deciding ties, a large number of good scores were counted out.

The dimensions of the targets used for individual shooting in the army are as follows :—

British Military Targets for Individual Firing.

Divisions	Value	Third class	Second class	First class
	Counting	Inches diameter	Inches diameter	Inches diameter
Bull's-eye .	4 points	12	24	36
Centre .	3 „	24	48	60
Outer . .	2 „	remainder of a target 4 feet square	remainder of a target 6 feet square	remainder of a target 6 feet by 8 feet

For sporting rifles, miniature rifles, and gallery shooting, the targets are so much smaller that they do not need to be on balanced frames. It is advisable, if circumstances allow, to have them on a frame attached to a little carriage running upon rails. This can be pulled up by an arrangement of cord or wire and a wheel to the firing-point after each series of shots, and fresh targets inserted, which are sent down to the butt again in the same way. The targets on the revolver range at Bisley, both at 20 and at 50 yards, have for some time been fitted thus, and on the range for the Martin Smith and miniature rifle competitions at 100 yards, a similar mechanism has been introduced. Such a means adds greatly to the safety of a range, but it is not available beyond the distance at which the shot-holes can be seen with a good glass in any ordinary weather, otherwise the shooter has no idea what he is doing. The bullet holes are often anything but easy to discern in the black bull's-eye of the Martin Smith target at 100 yards, especially since the almost universal reduction of bore in sporting rifles.

The writer's experimental shooting at 100 yards, a very good distance for a preliminary testing of charges and of rifles, is done at the Martin Smith target 12 inches square, with a 3-inch bull's-eye, dropped into a frame in the front end of a wooden box, 8 feet long, and about 18 in. square at the further end, packed with damp sawdust. From this the bullets are recovered uninjured, except in the case of those which are specially arranged to break up in soft-skinned animals. The lid of the box can be removed, and the sawdust sifted out, to recover the bullets. Perhaps this arrangement does not fairly come under the heading of target equipment, as it has its own special use, but it is worth describing for the benefit of those who like to examine the fired bullet, from which much of interest may often be learnt. The use of a water tank with a hole in the side covered with a piece of rubber through which the shots are fired, is too troublesome and expensive for most private ranges. With this, the bullets fall to the bottom of the tank and are caught on perforated trays, which can be lifted out. The strain on the joints of the tank from the hydraulic pressure set up by the bullets, is considerable, and tends to leakage.

It is well to be able to shoot on occasion at very much shorter distances than 100 yards. With an unknown rifle or charge there is a very great probability of missing too small a mark for the first few shots. Targets should always cover a wide enough angle to provide against such contingencies, and for general use, as for club shooting at 100 yards, the Martin Smith target is a good deal too small. The targets used at Bisley for revolver shooting are excellent for their purpose, and the 50 yards revolver target is by no means a bad pattern for general rifle work at 100 yards.

FOR SPORTING RIFLES.

Martin Smith Target; distance, 100 yards.

Central bull,	2	inches diameter	counting	7 marks.
Bull's-eye,	3	" "	"	6 "
Third ring,	4½	" "	"	5 "
Fourth ring,	6½	" "	"	4 "
Fifth ring,	9	" "	"	3 "
Sixth ring,	12	" "	"	2 "

Target, 1 foot square; the corners do not count.

Revolver Target; distance, 20 yards.

Similar to above, but only the 2-inch bull's-eye is blackened.

Revolver Target; distance, 50 yards.

Target, circular, on a square card, subdivided as follows:—

Bull's-eye, 4 inches diameter	. . . . .	counting	7 marks.
6 inches diameter, ring 1 inch wide	. . .	"	6 "
9 " " " 1½ " "	. . . .	"	5 "
13 " " " 2 inches wide	. .	"	4 "
18 " " " 2½ " "	. . .	"	3 "
24 " " " 3 " "	. . .	"	2 "

The corners do not count.

The size of the miniature standard targets recommended by the National Rifle Association for club use up to 100 yards will be found on p. 537.

Gallery ranges of from 25 to 35 yards were formerly a good deal in fashion in New York, and the writer remembers seeing one some years ago on Messrs. Rigby's premises in Dublin. The weapon most commonly used, as has been before said, in such indoor ranges, is the American rifle of ·220 calibre or thereabouts. In this case no very elaborate arrangement is

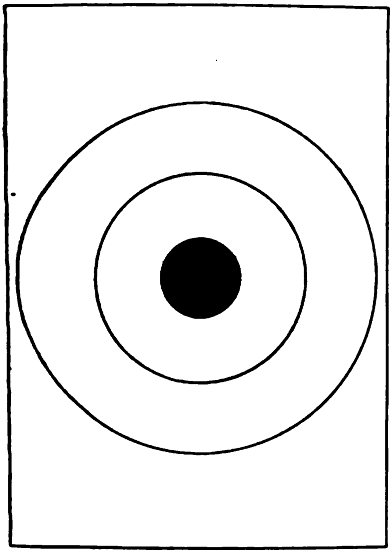


FIG. 89

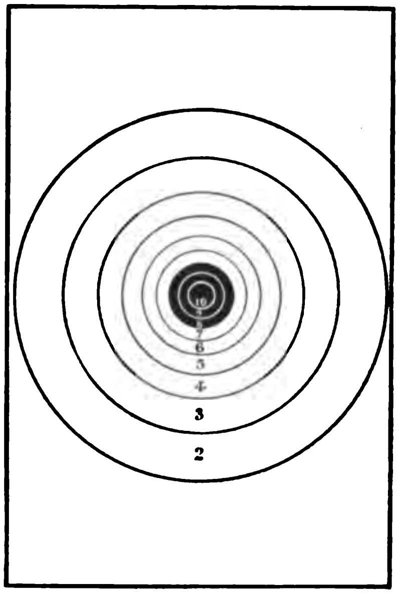


FIG. 90

necessary to stop the bullet, but it is as well to catch the bullets, and not to let them break up on an iron plate for fear of splinters. A favourite American target for gallery shooting (usually done off-hand) at 25 yards used to be as shown in fig. 89. This target measures 8·25 inches in height by 5·8 inches in width. The bull's-eye is 1·2 inch in diameter, having an inner carton of one-half that diameter. The inner circle is 3·25 inches across, and the next circle

5·4 inches. The Standard American target for use at 200 yards shown in fig. 90 was adopted in January 1886, by a majority of the American rifle clubs voting upon various proposals for targets. It is practically the same as the target designed by Major Charles W. Hinman, and known as the Massachusetts Decimal Target. The Standard Target has the following dimensions:

Diameter of Circles.	Width of Rings.
10 circle, 3·36 inches.	
9 „ 5·54 „	9, 1·09 inches.
8 „ 8 „	8, 1·23 „
7 „ 11 „	7, 1·50 „
6 „ 14·80 „	6, 1·90 „
5 „ 19·68 „	5, 2·44 „
4 „ 26 „	4, 3·16 „
3 „ 34·22 „	3, 4·11 „
2 „ 46 „	2, 5·89 „
1 Balance of target, 4 × 6 feet.	

For rest shooting two circles within the central 10 were afterwards added, counting 11 and 12. They are 2·33 and 1·41 inches in diameter. This is a good target, as giving a high value to close shots, but for military rifles and prize meetings on a large scale it is hardly suitable.

The small targets used for pistol shooting or gallery practice are very convenient, inasmuch as the firer can take away with him his own targets if he pleases, and this is always a source of interest. The writer knows one house in Sussex where several Martin Smith targets, with groups of shots on them of exceptional merit, are framed and hung as a record of the joint capacity of the owner and his Mannlicher rifle. To those who have not at hand the means of firing on a long range, a short range of from 50 to 100 yards, on which military rifles can safely be used, is of great value, although it does not constitute a supreme test. The writer has frequently made preliminary trials of the merits of different charges at 50 yards, and has been able to discard on this test those which showed any considerable want of accuracy.

CHAPTER XVII

THE HYTHE RANGES—FIGURE TARGETS—FALLING TARGETS—BALLOON TARGETS—TORPEDO TARGET—OWL TARGET—THE POPINJAY—TEAM MATCH AT BREAKABLE TARGETS—THE RUNNING DEER—MOVING TARGETS—ALLOWANCE FOR MOTION OF OBJECT

The School of Musketry at Hythe has a good assortment of ranges, some fitted with iron targets, and others with canvas targets on a similar system to that used at Bisley. It has also arrangements for targets which move across the line of fire, or diagonally to it. A very pretty target is one representing a section of advancing cavalry. There are half a dozen figures of horsemen alongside each other, which come on at a rapid pace. Firing begins as soon as they appear at about 800 yards from the firing-point, and as they advance gradually one and another falls until they have all tumbled over and disappeared from view before the end of the run, about 200 yards from the firing party. The effect is excellent, but it is not really the bullets which knock them over. They are fastened on a frame carried upon wheels which run upon rails. The figures are hinged, and at certain places in the course projections are arranged which trip over one or another of the figures as they pass. This is perhaps as realistic a target as it is possible to make. Within the last two or three years an interesting developement in targets, imported apparently from abroad, has been tried at Hythe. A wooden framework of some size has been erected, upon which boards and screens fitted to it can be fastened. These are shaped and painted to represent a house, a church tower, &c., so that an attack on an outlying portion of a village can be simulated. There is also mechanism worked from sheltered trenches by which figures of men are made to cross in front of the building, to enter a door, to appear at a window, &c., while a sentry is suddenly seen moving to and fro in front of his box, and another figure appears for a few moments at the top of the church tower and begins to wave a flag. Where targets arranged on such a principle as this can be safely shot at, no better practice can be imagined. The firing party has to advance with caution, and be prepared to open fire on the appearance of any of the enemy; and fire must be opened smartly or probably the figure will have disappeared. Another distinctive feature at Hythe is a large target some 30 feet square, made of iron plates fastened upon a brick butt, which can be used for shooting up to 2,000 yards. Hythe has the immense advantage of having the sea behind the targets, so that the shooting is very safe, but its flat shingles lend an air of unreality to attack practices, while the going is (speaking generally) as heavy as in any ploughed field. It seems a pity that the School of Shooting in this country should be divorced from our chief military centres of Aldershot and Salisbury Plain, and should not even be upon ground of fairly normal features. An immense amount of instruction may be gained on a small piece of country of varied contour, with rows of targets which can be made to appear and disappear quickly, concealed in trenches in many parts of it. Not only good shooting, but the proper tactical handling of fire, can under such circumstances be taught. A new enemy, for instance, suddenly appearing towards a flank, will necessitate a rapid change of dispositions, and the opening of fire in a new direction, while a really sharp look-out has to be kept. Such features as these are usually absent from field firing as hitherto carried out. To obtain them to the best advantage it is essential that there should be a sufficiently large number of installations of targets for the instructor conducting the practice to be able to make his choice at any moment among several that he could cause to be shown. This enables surprises to be made even where the firing squad and its officers already have some knowledge of the ground and the general position of the targets.

For purposes of practice in the field special targets are desirable. The idea of shooting at targets representing figures of men is a very natural one, and has at times been carried to extremes in the desire to make military shooting practical. The roughly-blocked-out row of black figures upon a white ground which was so much in vogue some years ago for military practice, is, in fact, hardly more practical, if at all, than the target with the bull's-eye upon it. The black figures produced an effect quite different from that of real figures of men, and there being no obvious central point of the target at which aim could be directed, the shooter had no assistance in learning to shoot accurately. There is this much to be said for the bull's-eye, that though it is a well-defined mark, quite unlike anything that will be shot at in sport or war, it teaches the shooter to be extremely careful of his aim both in elevation and in direction. The assumption, which is only now being abandoned, that the mark to be shot at in war will be a row of full-length figures close together even within the distance at which the trajectory of the bullet is within a man's height, is one which has long been unwarrantable except under conditions of savage warfare. The mark in war may be, as in South Africa, almost invisible. It may be that some portion of an enemy's figure will be seen; but it can only be exceptionally, and then not under conditions suitable for deliberate firing, that the whole of it will be exposed. Nor will the colour of the foe in future be much nearer to that of lamp-black than is a stag's coat. Figure targets, for field firing, at all events, should never be black, and especially not black on a white ground, although for teaching accuracy, and testing accuracy, the first condition of all is that the mark should be absolutely distinct. This is why for ordinary range practice khaki targets are unsuitable. Their distinctness varies with the changes of light, even supposing their colour not to be changed by wet. The Swiss in their military target endeavour to combine the figure target and the bull's-eye target by placing a head and shoulders figure, such as conventionally represents a man lying down, within the central circle of the target. This is probably useful to indicate to the firer the degree of accuracy required to hit an enemy lying down in open ground at any given distance, but for instructional purposes it is less good than the circular black bull's-eye. In the Swiss course of instruction the recruit proceeds to shoot, from behind cover and with a rest for his rifle, at targets divided into bands, with rows of figures represented upon them. These Swiss military targets are shown in fig. 91.

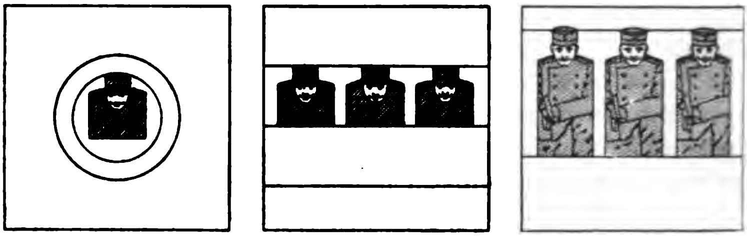


FIG. 91

We borrow from Mr. Gould's admirable book a sketch of some very good silhouette figure targets, designed for American army practice by Captain Blunt (figs. 92, 93, 94). It is better to make such figures of mill-board, and to support

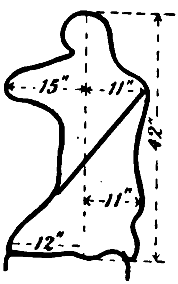


FIG. 92

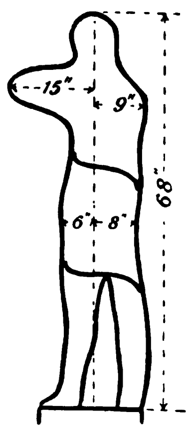


FIG. 93

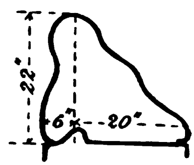


FIG. 94

FIG. 95

them on a light wooden upright, than to have the figures made in iron wire and covered with canvas. The appearance of the same figures at a distance is shown in fig. 95.

It is a mistake to try to subdivide figure targets for scoring purposes, unless, as with the running deer or man at Bisley, the distance is short enough to allow of a wide distinction being fairly made between the right and the wrong part of the figure. In shooting, for instance, at the figure of a rabbit at 100 yards, a bull's-eye to represent the immediately vital parts would have to include the brain, the neck, the heart, and the spine, and very little else, but at such a distance it is almost an absolute fluke as to whether a well-directed shot does or does not touch a vital spot.

Many attempts have been made to devise a penetrable target which would fall on being struck by a bullet. The problem is by no means an easy one. The target must be so arranged that it will stand firm in a strong wind, and yet infallibly be knocked over by the slight jar made by the bullet passing through it. The most successful target of this kind that the writer has seen is one on a principle invented by Captain Otter, of the Swiss army. It is a head and shoulders target made of wood from half to three-quarters of an inch thick (fig. 96). This is placed nearly upright on the ground, and is supported by a light bar of wood about 2 feet long, one end of which, being pointed, bears upon the ground, while about 3 inches from the other end a slight notch is cut, which fits against the shoulder or some projecting nail or hook on the target. A lever 9 or 10 inches long, made of iron, turns freely on a pivot fixed at about 3 inches from one end just below the point against which the support rests. This lever tends to hang from its pivot with the long end downwards, but a small rounded peg, projecting not more than about $\frac{1}{10}$ inch from the surface of the target, is so fixed that it will support the long end and keep the lever horizontal when the target is sloped slightly backward. In setting the target the lever is placed horizontally, and held fast while the support is arranged so as to keep the target nearly upright. On a shot striking the target jar enough is given to it to release the lever from off the peg; the long end of it falls, and the short end, rising against the projecting end of the supporting wooden bar, lifts it so that its notch no longer supports the target, which therefore falls over.

Such a target when made of wood answers its purpose more satisfactorily than others on a similar principle made of millboard or papier-mâché. A certain thickness of wood is required to develope the jar caused by the bullet.

A few targets on this principle set among screens, on which head and shoulders targets are painted, are of

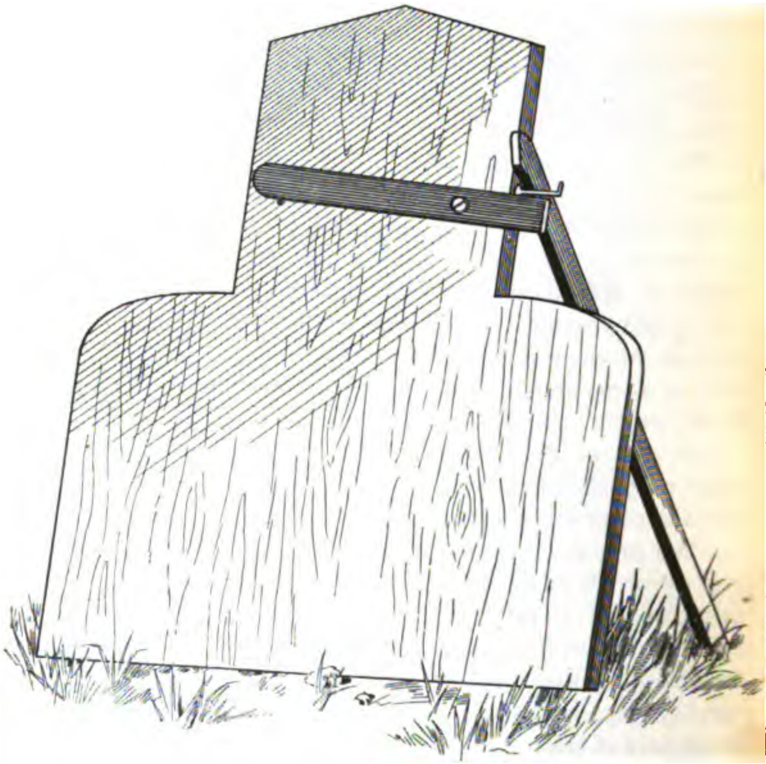


FIG. 96

immense assistance in field firing, and show when the sighting is correct, and the fire effective, much as a living mark would show it. It is a great disadvantage of fixed targets that there is so little to indicate when the range has been found and the bullets are striking in the proper place. These falling targets have two disadvantages. First, they require some little care in setting, and each has to be separately put up in readiness for the shooting, a matter of some labour if a large position is to be represented as being held. Secondly, when, as happens sometimes, a bullet strikes the iron lever, it usually smashes the whole target.

To vary rifle practice and to make it interesting, balloon targets have sometimes been used. These are merely inflated bladders such as children use for toys, of about the size of a man's head. It is an excellent test of marksmanship for the individual to see whether he can break six of these in six shots at 150 or 200 yards in a limited time. The only objection to them is that they require some preparation, that they are not very steady in a wind (although this is not necessarily a disadvantage), that sometimes they are liable to deflate themselves without being punctured by a bullet, and that if not absolutely spoiled by the shot they require patching before being used again. When these fragile targets are used they should be placed so that they cannot easily be broken by stones or bits of earth thrown up by the bullets striking short.

In 1863 at Wimbledon there was pool shooting at plates of common crockery, but the broken fragments of such targets are apt to lie about and become a nuisance.

Fancy targets are sometimes useful and interesting, since they make variety for competitors, but they are as a rule unsuited to ordinary competitions, or to the conditions of a large meeting. Much interest was taken at the Wimbledon meeting of 1877 in what was called a torpedo target. It had been arranged by Mr. Martin Smith and Mr. Metford, and consisted of an ordinary third-class canvas target with a 6-inch bull's-eye for shooting at 200 yards. In front of the bull's-eye was an invisible disc of wood, 4 inches in diameter. If this disc were hit its movement discharged a Snider rifle loaded with a blank cartridge, concealed behind the target. Some such device, giving as it does a very conspicuous result to a successful shot, is worth adopting at times for novelty's sake.

At Wimbledon at a much earlier period (1864) an endeavour was made to establish a competition for firing at night, and the following is the advertisement which notified it to the competitors:

OWL SHOOTING EXTRAORDINARY.

Oh yes! Oh yes!

Take Notice All.

A prize of £50 has been given by the Venerable the Owls, of the *Owl* newspaper, to be competed for on such terms as the Council may fix.

Out of consideration for the generous but benighted donors, the Council have determined that the competition shall take place in the dark, at the 200 [yards] Pool Targets.

Lights, called Owl's-eyes, will be substituted for the plates now used as bull's-eyes at these pools.

Conditions:—

Each competitor shall pay 1*s*. per shot as at pool, and if the competitors do not appear in great numbers,

'The moping owl will to the moon complain.'

The prize, which will be in the form of a beautiful silver owl, shall be adjudged to the competitor who shall, by the end of the meeting, have made the greatest number of owl's-eyes; that is, who shall have oftenest knocked out the owl's-eye, or broken the glasses by which it will be shaded.

Every precaution has been taken to guard against accident.

The shooting will commence at dusk.

The shooting at this target was decidedly difficult, the small disc of light being a very unsatisfactory object against which to define the sights. Many competitors entered and fired a series of five shots, the signals from the target being made by means of coloured lanterns. Mr. Martin Smith won the first prize, hitting the 'owl's-eye' four times in ten shots. One competitor burnt his hand badly in preparing phosphorus to make his sight luminous. The competition was never repeated; it was not practical, and it involved considerable elements of danger.

Mr. Gould describes a fancy target, borrowed probably from Germany, made to be set up on a pole some 40 feet high. The various parts of a double spread eagle, holding a ball, sceptre, &c., and decorated with flags and a crown, which are pegged into a thick wooden shield, have to be successively knocked away by well-placed shots. In the centre of the body is a circular iron plate, with a ¾-inch hole in the centre, and a bullet penetrating this explodes finally a dynamite cartridge, which destroys the remains of the bird's body, after its limbs and appendages have all been shot away. The custom of shooting at such a bird-target is no doubt the lineal successor of the ancient fashion of shooting at a popinjay, or other bird, fastened to the top of a pole, which has existed from time immemorial in this and other countries. Indeed, it is described in Virgil's account of the sports in the fifth book of the 'Æneid.' The bow and arrow were the weapons used; the first shooter struck the top of the mast, the second cut the cord by which the pigeon was tied to it: the third pierced the bird as it flew away and brought it to the ground. In the last couplet:

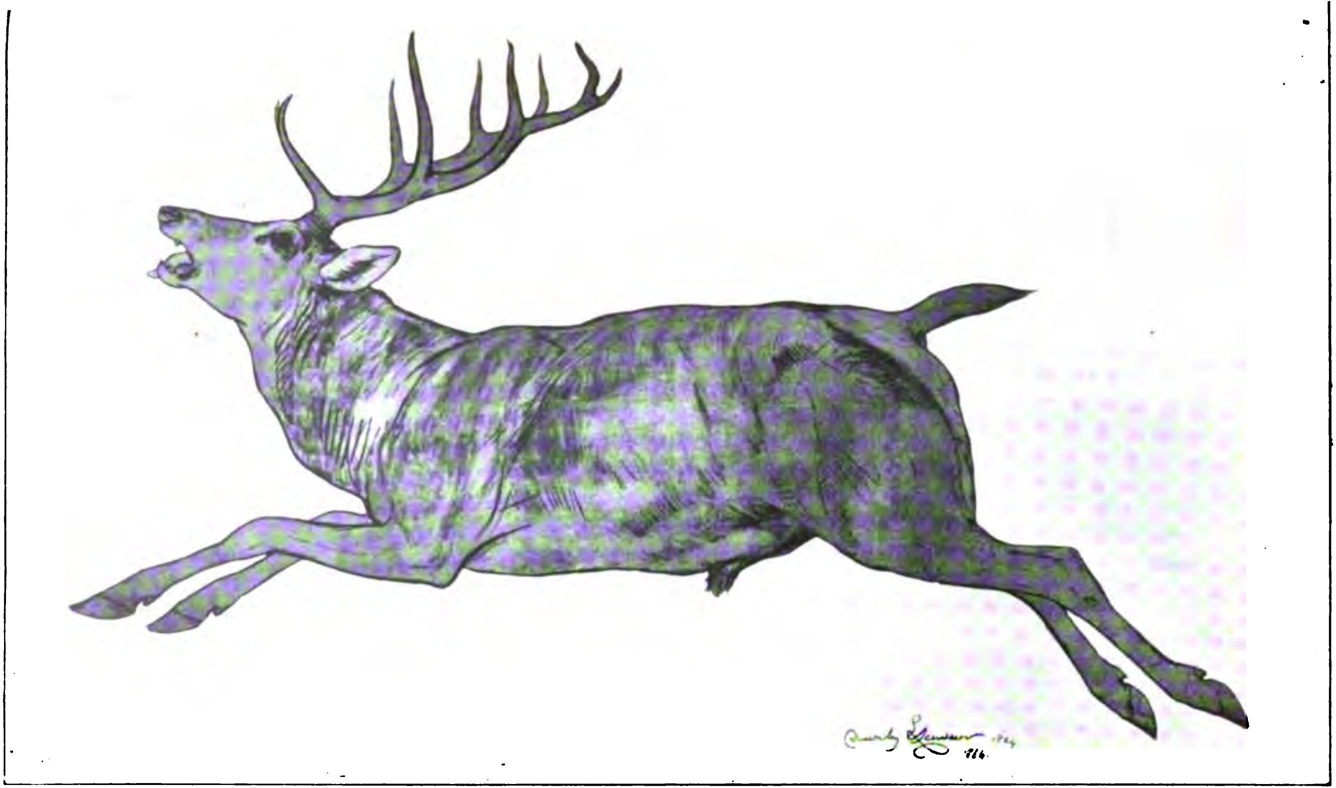
> 'Decidit exanimis, vitamque reliquit in astris
> Aeriis, fixamque refert delapsa sagittam,'

we seem to hear the rustling fall of the bird, more and more rapid until at last it strikes the earth.

The mythical feat of pigeon shooting here described is worthy of the traditions of Robin Hood and Little John, and, it must be feared, as a matter of skill, as impossible as any of their performances.

An interesting match between two small teams may be made as follows. The distance being 200 to 300 yards, the teams are drawn up alongside each other, with a small interval, and numbered from right to left. At the butt opposite each team is a row of small targets, similarly numbered, and each representing one man of the opposing team. The targets may be of some fragile material; cheap white dinner plates answer very well, or they may be bladders, such as have just been described, or any sort of targets which fall when hit. Small iron or steel plates can be made to answer the purpose. In fact, the only essentials are that they should be quite independent of each other, and should disappear when struck by a bullet. The teams begin firing at the same moment. Let us call them Team A and Team B. In the course of a few rounds Team B, which is firing at the row of targets representing the members of Team A, hits No. 1 target of that row. The umpire with Team A (there being an umpire for each team) at once puts out of action No. 1, the right-hand man of the team. He is treated as a dead man, and his ammunition may be used by the survivors. Similarly, Team A may quickly put one of the members of Team B out of action. It may be good tactics to concentrate fire upon the targets representing the best shots of the opposite team. The match is won by the team which has the greater number of survivors – targets and men—when the stated number of rounds have been expended, or when the firing has continued for the time agreed upon; or the event may be fought out to a quasi-bloody finish, and decided by the complete extermination of one side or the other. Such a match, though unsuited to a large gathering at which competitors are many, accommodation limited, and time short, has very practical features. There is something in it of that element of excitement which is prominent in sport and in war, and very apt to be demoralising to the inexperienced. Such a match, too, gives something of the spectacular interest in which rifle practice is usually so deficient, for the effect of the shooting is plainly visible and immediate.

Practice at moving targets is by no means so easy to arrange as at fixed ones, but it is of great value in giving command of the trigger and cultivating that decision of mind which is necessary to make a successful shot in the field. The best known moving target is undoubtedly the running deer, as used at Wimbledon and Bisley for many years past. We are permitted to give (Plate XLVIII) a copy of the life-size drawing which Sir Edwin Landseer made at Lord Wemyss' request in 1864 as a model for the running deer target then set up at Wimbledon. The drawing has been ever since in the possession of the National Rifle Association. The Wimbledon deer was very heavy, being made of a thick iron plate, and was mounted upon a heavy little truck, and so pivoted that it could be turned round on arrival at one end or other of its run so as always to travel head foremost. The deer thus mounted runs upon rails of a narrow gauge, and being pushed off at the top of an incline, runs down it and maintains sufficient impetus to mount up the opposite inclination and to reach the other marker's butt. At Bisley the whole length



SIR E. LANDSEER'S DRAWING FOR THE ORIGINAL RUNNING DEER TARGET AT WIMBLEDON, 1864

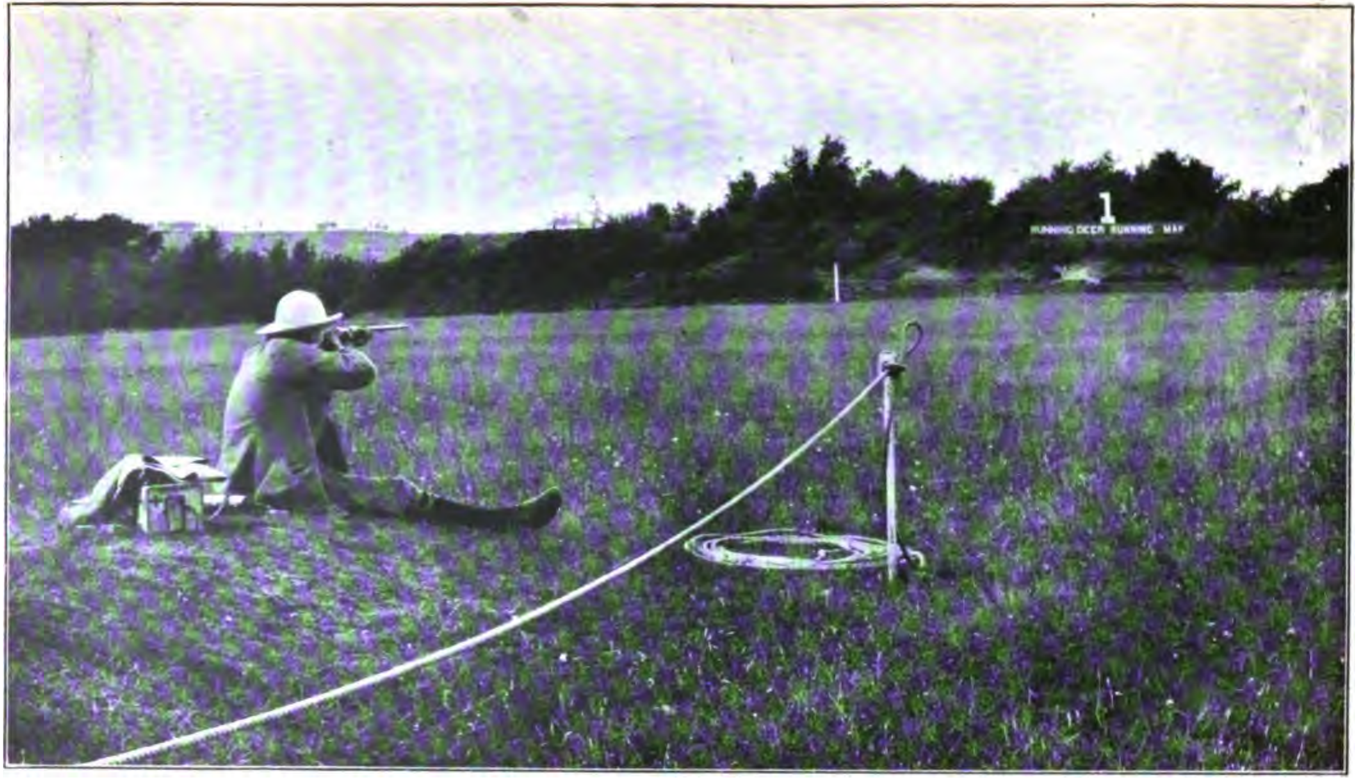
of the run is about 55 yards, and the amount of the dip 4 feet 6 inches. Two white posts are placed upright in front of the range 25 yards apart and at a few yards' distance from the markers' butts; these limit the part of the run available for firing, so that the men may not be endangered by the discharge of a shot at the deer just as it is entering the butt. With the deer made of iron there was always some danger from the fragments of the bullets, and the markers were occasionally cut by splashes of lead. The introduction of high-velocity rifles with compound bullets increased this danger considerably, and in consequence the running deer, like the other targets, has now been made penetrable, and is merely composed of thin planking covered with paper, and held in place by two uprights. Unfortunately the antlers, which were a feature of the iron deer, have had to be discarded in the case of the wooden one. The deer is painted a yellowish brown colour, and although a six-inch bull's-eye (representing the heart) and an inner ring are outlined upon it, these are not coloured differently from other parts of the animal, and are not visible from the firing-point. Another division marks the haunch, which is very easy to be hit by the inexperienced, and by the old Wimbledon rules involved, when hit, a substantial fine. A low bank in front of the track hides not only the rails, but the carriage on which the deer is fitted, so as to save it from damage, and makes it appear as if the deer were moving along the ground. The figure of a running man, arranged on exactly the same principles, is fitted to the same track.

We give (Plate XLIX) an illustration of the running deer range at Bisley, with Mr. Ranken in the foreground in the act of firing, and the deer in the middle of its course. The dummies, painted white, on which the hits are marked are also visible. The distance for shooting at the running deer is 100 yards, and Mr. Ranken's record score of 22 out of a possible 24 points, five bull's-eyes and one outer in six shots, is well worthy of mention.

The iron deer was equally good on either side, and could be reversed, but with the wooden deer this is not possible, chiefly on account of the splintering on the far side by the penetration of the bullets. It is therefore necessary to have two deer facing opposite ways, the one facing to the right being carried flat upon the truck so as to be out of sight while the run is made to the left, and *vice versa*. It is convenient to fix the two deer nearly at right angles to each other on a horizontal pivot in the middle of the truck, so that raising one lowers the other. Sir Edmund Loder's running-deer range at Leonardslee has the deer fitted in this way. A great advantage of the reduced weight of the penetrable target is that the carriage can be made much lighter, and with well-made wheels and rails the labour of starting it is by no means the severe task which it used to be when the deer was made of solid steel or iron.

It is not difficult to make simple arrangements to show moving targets on an ordinary range. A figure target may be carried above his head by a man walking in the markers' gallery of a range, or it may be carried upon a small truck or sledge worked by a windlass; or it may be hung upon wires.

Moving targets for gallery shooting and shooting at short distances are made on various principles. One modern idea is to set up an oscillating incline upon which rolls a hoop 2 or 3 feet in diameter fitted in or near the centre with a small circular target. Or the track may be straight and may have a hinged piece at either end, which can be raised high enough to give the necessary impetus. In either case the mechanism can be arranged for short distances to be worked from the firing-point. Such principles as these admit of a variety of modifications. In one system hoop targets run between wire guides which prevent their leaving the track or falling sideways. It is both interesting work and useful practice to shoot with a small rifle at a block of wood hanging by a long cord or chain so as to swing slowly across an opening. To make good shooting at a moving target it is necessary to be able to fire correctly, not only for line and for elevation, but for time, that is, to discharge the shot at the precise instant when the aim is right. It is truly said in 'The Perfection of Military Discipline after the Newest Method' (1690) that 'in firing at a thing in motion you must consider the swiftness of it and fire in your aim a distance before, and so



THE RUNNING DEER RANGE AT BISLEY: MR. RANKEN FIRING

the bullet by that it moves that space will be there, for although a bullet is carried with impetuosity, yet all motions require time.'

Shooting at the running deer at Bisley is decidedly less difficult with modern rifles, with which, owing to the greater speed of the bullet, the aim is little more than a foot in front of the point to be hit, than it was with the old Express rifles, or with the rook rifles so often used at Wimbledon, which required two or three times this amount of allowance. One very old shot, Lord Wemyss, considers that the best way to maintain the elevation and to get the allowance on any running animal is to aim first of all behind him, and then, swinging the rifle so that the sights pass over his body at the right height, to fire when what is judged to be a proper distance in front has been gained. Of these things the writer does not speak as an expert, but, as in shooting with the gun, the secret of success certainly lies in forming the habit of not checking the motion of the weapon at the instant at which it is fired. A very experienced shot with the rifle at moving objects once expressed strongly his conviction that it is all-important to move the whole of the upper part of the body with the rifle, turning it upon the hips, and not to attempt to let the arms do the work.

The allowance in front of the object aimed at consists, if the rifle be kept moving until the bullet leaves it, in the travel of the object during the flight of the bullet; but if the rifle is pitched up and fired at a point ahead of the object, additional allowance will be required on account of the time which the impulse from the brain takes to set the trigger in motion, and also for the time taken by the lockwork in moving, by the charge in igniting, and by the bullet in travelling to the muzzle. Thus, if, as must often happen in military shooting, those firing have not very great experience at moving objects, the allowance should be more than enough merely to compensate for the movement of the target while the bullet is in the air. The deductions arrived at by Lieut.-General Rohne, based upon the time of flight of the bullet, are that against targets moving at a trot the aim should be one yard in front for every 100 yards range, and against targets galloping two yards. It is necessary at anything but the shortest ranges to take into account the direction of the wind, which may either increase or materially reduce such allowances as this. Generally speaking, it would be enough to aim at the head of a moving column at almost any distance, since a small column would not be fired at at any very long range. The safest place in the column would undoubtedly be at its head, just as it may be noticed that when men fire at a row of figure targets hardly a single shot will strike the flank figures, while the centre ones are riddled. We append a table showing the time of flight of the ·303 bullet up to 2,000 yards, and the amount of space which will be covered by a man at a slow walk or double, and by a horse at a trot or gallop, moving across the line of fire during the time of flight. The times of flight are calculated by the method laid down in the Text Book for Small Arms, 1894.

Range	Remaining Velocity, f.s.	Time of Flight of Bullet, in Seconds	Rate of Motion of Object across Line of Fire: Miles per Hour: 3	6	9	12
			feet	feet	feet	feet
100	1,831	·157	·691	1·382	2·073	2·764
200	1,673	·328	1·443	2·887	4·330	5·774
300	1,525	·516	2·271	4·542	6·813	9·084
400	1,387	·723	3·182	6·364	9·546	12·728
500	1,265	·950	4·181	8·362	12·543	16·724
600	1,162	1·197	5·268	10·536	15·804	21·071
700	1,086	1·428	6·285	12·569	18·854	25·138
800	1,016	1·754	7·719	15·439	23·158	30·877
900	978	1·992	8·767	17·533	26·300	35·067
1,000	925	2·375	10·452	20·905	31·357	41·810
1,100	886	2·703	11·896	23·792	35·688	47·584
1,200	849	3·056	13·450	26·899	40·348	53·798
1,300	816	3·411	15·012	30·024	45·035	60·047
1,400	784	3·794	16·697	33·395	50·092	66·790
1,500	755	4·174	18·370	36·740	55·110	73·480
1,600	726	4·588	20·192	40·383	60·575	80·767
1,700	699	5·005	22·027	44·054	66·081	88·108
1,800	673	5·438	23·932	47·865	71·798	95·730
1,900	647	5·904	25·983	51·967	77·950	103·934
2,000	623	6·367	28·021	56·042	84·063	112·085

N.B.— 1 mile per hour = 1·467 feet per second.
3 miles „ „ = 4·401 „ „ „
6 „ „ „ = 8·802 „ „ „
9 „ „ „ = 13·203 „ „ „
12 „ „ „ = 17·604 „ „ „

A rough rule easy to remember is that $\frac{2}{3}$ of feet per second = miles per hour.

The study of such a table as this will be of practical use in giving, at all events, some basis on which to work, instead of leaving the amount of allowance merely to be guessed. It is not necessary to trouble much about the allowance for objects moving diagonally to the line of fire, for it is near enough to say that if the allowance be 10 or 20 feet ahead of a mark crossing the line of fire, it will be equally 10 or 20 feet ahead of the same mark moving diagonally, only that the allowance must be made in the direction in which the target is moving. It is clear enough that at a retiring or advancing enemy the elevation used should be a little higher or a little lower than is required for the actual distance, so that the full effect of the fire may at some moment be brought to bear by the enemy moving into the bullet-swept zone.

CHAPTER XVIII

THE BISLEY MEETING—ITS MANAGEMENT—SQUADDING—REGISTER TICKETS —PROCEDURE IN SHOOTING—SCORE REGISTER TICKETS OF A KING'S PRIZE WINNER—TIME ALLOWED FOR SHOOTING—SIGHTING SHOTS—CHALLENGES—NATIONAL RIFLE ASSOCIATION'S REGULATIONS FOR RIFLES AND AMMUNITION—UNAUTHORISED ASSISTANCE—TEAM SHOOTING—THE CAPTAIN AND THE TEAM

THE Bisley meeting is to many riflemen the central event of the year, and if a few notes are here put down on the organisation and method of that meeting, it is largely because the experience of Wimbledon and Bisley is valuable in arranging for rifle meetings, even on a much smaller scale. The competitions of the National Rifle Association are fenced about with very elaborate rules and regulations relating to all the conditions of shooting, and to every detail connected with the marking and the procedure under all circumstances which may arise. This is the inevitable consequence of a real attempt to provide equitable conditions as between different competitors. Rules must be clear, and they must be complete, or some one or another in a fashion entirely within his literal right will stretch a point to place himself at an advantage. This is a very natural result of ingenuity, which within reasonable limits no one could wish to discourage. The regulations of the National Rifle Association have been built up, not by an endeavour to create restrictions, but by the necessity of providing for cases which have actually occurred.

In a small association among friends, where all shoot under equal conditions and are well known to each other, there is usually not the same need for a complete code of rules, since the game is played in the right spirit, and all those who play it know each other. But this is not the case at a large public gathering at which men meet who live at long distances apart. Another difficulty at a large meeting is that the markers and those superintending the shooting are doing work to which many of them are unaccustomed, and, therefore, to ensure uniformity of administration, the various questions which may arise must be very completely provided for beforehand.

At Bisley the management of the meeting and the hearing of any disputed cases or claims connected with the competitions are in the hands of a small committee, which sits daily during the midday interval, and again when shooting ceases for the night. The cases which come before it are, considering the scale of the meeting, very few, and in almost all of these an admirable spirit is shown by those who have a complaint to make, or a claim to bring forward. The cases are very exceptional in which any attempt is made to set up a claim to a score or a prize on anything but the most reasonable ground. Hard cases, of course, sometimes arise, and are treated with all consideration. At the same time, in fairness to those who are careful, as well as to give a strong inducement to the correct observance of rules, it would be an administrative mistake to allow leniency to degenerate into laxity.

In conducting a rifle meeting on a large scale some form of squadding or telling off competitors to a particular target at a particular time is necessary. At Bisley, where the large number of shooters and of targets necessarily demands very complete arrangements, many hundreds of entries are made for the more popular competitions. These are, speaking broadly, divided into two categories; competitions for which only a single entry is allowed, and for which the squadding or detailing to time and target is done beforehand; and those which are not restricted to a single entry, but may be shot for by a competitor presenting himself at any time, so far as target room allows.

It would be hard to conceive how the organisation of a rifle meeting on such a scale could be carried out without the device of making the entry ticket carry the actual register form on which the score is entered shot by shot as it is made. Any form of register sheets would be troublesome and confusing, and, above all, difficult to deal with in the Statistical

Department, which has not only to sort out the high scores from the low ones, but to arrange scores of similar totals according to the order of their merit under the rules laid down for the decision of ties without shooting off. The system which has been in force at Wimbledon and Bisley since 1866 is as follows. Each register card has a square hole perforated in it near the centre, to enable it to be filed upon an upright wire or peg or to be tied with others for safe conveyance to the Statistics Office by passing a string through the hole. Consequently, taking for example a competition of seven shots, in which 35 points is the highest possible score, the tickets when they arrive at the Statistical Department are promptly sorted out, all the 35's being filed upon the same peg, and on the next pegs all the 34's, then all the 33's, and so on, according to the rules for 'counting-out' ties. The cards containing scores so low as not to need consideration for the prize list are put aside, but still preserved for reference. On each peg the cards are arranged in their order of merit, and when the competition is closed and all the cards have been received it is quite a simple matter, though sometimes a very laborious one, to check them over and to copy the names and totals in their order in the form of a list on a single sheet of paper.

A competitor on paying his entrance fee for one of the squadded or single entry prizes receives a ticket on which is entered the day and hour at which he will shoot, the butt, and a letter denoting the target. This does not correspond to any particular target in the butt. The targets are permanently numbered, but the range officer tells off a particular letter to each at the firing-point, varying the lettering in the morning and afternoon of each day. Thus, if the targets on his butt are numbered from 31 to 40, he will letter these with the first 10 letters of the alphabet, so that a ticket squadded to 'G' target will have to be shot at whichever of them bears for the moment the letter 'G,' and no competitor can tell beforehand at which target he will shoot at any particular time. It was this previous knowledge which rendered possible the marking frauds at Wimbledon twenty years ago.

The theory at Bisley, and it is a very sound one, is that the scoring of each man's shots should be witnessed by those shooting with him, and by any casual spectators. If he is shooting alone, the range officer or some spectator undertakes to act as a witness of the scoring. By such means fraudulent collusion between competitor and register keeper at a time when there are few people shooting is guarded against. The register ticket has conspicuously printed upon it the title of the competition for which it is used, and while the tickets for no two prizes are quite alike in colour, the colouring of them is so arranged as to denote the class of competition to which they belong. Spaces are left upon the ticket for the name, rank, and corps of the competitor, and, where the conditions demand it, for the type of rifle and ammunition used by him. Below this is a row of spaces in which the value of each shot, including the sighting shot, is recorded by the register keeper as it is marked; when the score is complete, he fills in the total and signs his name on a space provided for the purpose. The register keeper has alongside him a blackboard with spaces for the names and for each shot fired, and as each competitor in a squad fires his name is called out, and, when the shot is marked, its value, thus: 'Private Smith, bull's-eye, 5.' At the same time the value of the shot is written on the blackboard and the total score is afterwards written there. The object of this is to ensure publicity, both for the benefit of the competitor, who hears the shot called out and can himself see that it is written down correctly, and also for the protection of the public, because it is obvious to the officer in charge of the range or to any casual spectator whether or not the value scored for any shot on the blackboard corresponds to the value actually marked upon the dummy. Sometimes by a slip of the tongue a register keeper, unused to Bisley scoring, will call out 'Bull's-eye 4'—instead of 5, and unless corrected make a mistake in writing it down. Such errors are not very common, but unless a competitor is vigilant he may be disagreeably surprised at finding some mistake made. Shots fired by one man have sometimes been attributed in the scoring to another man firing alternate shots with him. Any question as to the correctness of the scoring must be raised on the spot and at the time. The shooting of the squad being complete, and the score entered and added up on the card as well as on the blackboard, the range officer is called to check the scores as entered on the tickets by those on the blackboard, and having done this stamps the tickets with his own check mark. If a score large enough to be likely to come into the prize list has been made by one of the men who have just completed firing, it is likely that he will be called upon to have the trigger of his rifle tested to see that it is not lighter than the limit of 6 lb. While the checking is being done, the squad who are detailed to fire next take their places and prepare to begin. The whole process, when officers, register keepers, and competitors understand it, works with great smoothness.

We are able by the courtesy of Lieut.-Colonel Crosse, Secretary of the National Rifle Association, to give a reproduction on a reduced scale of the register tickets (Plate L) on which the score of Lance-Corporal Ommundsen, the winner of the King's Prize of 1901, was recorded. The full size of the larger tickets is 4 inches by 2¾ inches. The particulars of the squadding may be noticed, and also the signature of the non-commissioned officer acting as register keeper at each distance, and the mark of the range-officer's number-punch, showing that he has verified the score on the ticket as tallying with that written up on the blackboard, and has checked the addition of the total for the distance. The shooting shown on the tickets was not sufficient to win the prize for Ommundsen, as Sergeant Burr, a Hampshire volunteer, completed his shooting with exactly the same aggregate score. The other competitors having finished, these two laid down to fire three shots each at the same target at 1,000 yards. Burr began with a magpie, but Ommundsen found the bull's-eye with his first shot. The Englishman firing with evident anxiety, and dwelling far too long upon his aim, made another magpie. With the next shot Ommundsen, who shot with great coolness, and fired carefully but not slowly, made another bull's-eye. He had thus ten points to the other's six. Burr's third shot was again a magpie, and his total for the three stood only at nine.

PLATE L


KING'S 1st Stage, S.R. 1901. Volunteers only. Division F. Day: Mon. 15, Tues. 16. Hour: 900-11.20, 500-4.40, 600-10.0. Butt 8. Target E.

Rank Lce Cpl. Name H. Ommundsen. Corps Queens Edinburgh

Sighting									Totals
4	200	4	5	5	4	5	5	5	33
4	500	5	5	5	3	5	5	4	32
5	600	5	3	5	5	3	5	4	30

Aggregate 95

R. Millar Serjt. Regt. Register Keeper for No. 17 Target at 600 Yards.

KING'S.—1901. S.R. 600. Second Stage. FRI 19 9.5 9 C 255

Name H. Ommundsen. Rank Lc Cpl. Corps Queen's Edinburgh

Sighting												Total
3	600	5	3	5	5	5	5	4	5	3	5	43

Richard Howley Cpl. Register Keeper at No. 25 Target. 13031

KING'S.—1901. S.R. 600. Second Stage. FRI 19 9.0 2 G 255

Name H. Ommundsen. Rank Lc Cpl. Corps Queens Edinburgh

Score made in First Stage. Total 1st Stage 95

Competitor to enter here the score made at 600 Yards in Second Stage 43

Sighting												Total 2nd Stage
5	600	5	5	5	4	5	5	0	4	3	5	41 — 84

Serjt. Regt. Register Keeper at No. 7 Target. Total 179

KING'S.—3rd Stage. S.R., 1901. 800, 900, & 1000. SAT. 20 1.40 4 D 79

Name H. Ommundsen. Rank L Cpl. Corps Queens Edinburgh

Scores obtained: 1st Stage 33 32 30; 2nd Stage 43 41; Totals 179

Sighting												Totals
4	800	5	5	5	5	5	2	5	5	3	4	44
5	900	3	5	4	5	4	5	4	3	5	5	43
3	1000	4	3	5	5	5	3	5	4	5	3	44

H. Campling. Grand Total 306 310

BISLEY REGISTER TICKETS, SHOWING LANCE-CORPORAL OMMUNDSEN'S SCORE FOR THE KING'S PRIZE, 1901 leaving Ommundsen one point ahead with a shot to spare—a most creditable victory.

In the early Wimbledon days of muzzle-loaders, and of more insistence upon military forms than at present, the squad of competitors used to be drawn up behind the firing-point, and step forward in rotation one at a time to fire. This made a very long process, and the introduction of breech-loaders enabled two or three men to take their positions alongside each other at the firing-point, and to shoot alternate shots. For many years the normal method of squadding was to tell off two men to fire together, and to allow them a quarter of an hour to fire their seven rounds. Thus eight competitors could fire at the same target within an hour. A saving of time was afterwards effected by squadding three men at a target and allowing them twenty minutes for each seven shots, and by this means nine instead of eight men could fire in an hour. This was found to work well, and when sighting shots (which had existed in early Wimbledon days and been abandoned) were re-introduced, the twenty minutes were found to give time enough for three men to fire eight shots each, instead of seven, that is, twenty minutes for the firing and marking of twenty-four shots. It must be allowed that unless all goes smoothly, the time is not more than enough. Some elasticity has to be given by leaving occasional blank times during which no squad is told off to the target, so as to allow for any small accumulation of lateness. The maximum time for each shot which the regulations recognise in deliberate firing is one minute for each shot from the time when the target is clear and ready to be fired at. At the long ranges half an hour for three competitors firing ten shots and a sighting shot each is none too much, since the larger target surface which the markers have to look over before the shot is found, and also the greater weight of the targets, tend to make the marking slower than at short distances. Sometimes, though rarely, the squad will be delayed by some defect in the target mechanism, or by slowness or carelessness on the part of the markers. Lateness caused by delays of this kind is, of course, not imputed to the competitors.

We have spoken only of the 'squadded' competitions for which all arrangements are made beforehand, but there are others, chiefly those in which an unlimited number of entries are allowed, tickets for which can be bought at a Box Office near the firing-point, or at the central Entries' Office in the camp. In these the same principles, and, indeed, the same details, mostly apply. A competitor having paid the entrance fee receives a ticket in exchange, fills in his name, and takes it to the firing-point, where the range officer details him at once to a target if there is room. The sighting shot is compulsory in practically all the competitions at Bisley. It was found impossible to make it optional, as otherwise an unscrupulous competitor, dealing with a weak or a muddle-headed register keeper, would be able, if his first shot were a bull's-eye, to claim that it was not a sighting shot, and if it were a bad shot to claim that it should be scored as a sighting shot. On such points misunderstanding easily arises, even when there is no desire to take an undue advantage. One reason why sighting shots are not likely to be done away with at Bisley is because the ranges are constantly used by some Volunteer corps and rifle clubs at other times than during the meeting, and a stranger coming from a distance for the meeting only might think himself at a disadvantage as compared with those who habitually use the range, if he were not allowed a preliminary shot.

Firing at the wrong target makes the competitor liable to a fine of 2*s.* 6*d.* The penalty used formerly to be 5*s.*, but such a sum, though it may have been suited to the purses of the class of men who formed the bulk of the competitors at Wimbledon thirty years ago, would press hardly on the means of many of the keenest and best of the shooting men of later days. It is necessary to have some penalty, both to check carelessness and to guard against the possibility of a man who has himself no prospect of winning a prize, firing purposely at his neighbour's target in hopes of improving his neighbour's score. As a matter of fact, in a considerable number of cases the self-inflicted penalty of losing the shot, which of course is scored as a miss, and so spoils all prospect of a really good score, and very possibly of a prize in an 'aggregate' competition, is a far heavier punishment than the pecuniary fine.

It is a common provision at rifle meetings that a small sum should be deposited if it is desired to dispute the marking of a shot, or to claim a hit when nothing has been signalled in response to the shot. If the marking is, on examination of the target by the officer in the butt, found to have been incorrect, the money is returned, otherwise it is forfeited. In old days the marker had to come into the open to examine the iron target, and thus delay was caused in the firing at neighbouring targets, and much time was wasted. The National Rifle Association, not long ago, very properly reduced the payment for such a challenge from *5s.* to *2s. 6d.* The poorer class of competitor finds the smaller sum quite large enough to pay, and with proper telephone arrangements there is very little trouble in communicating with the butt, while the target concerned has only to be pulled down into the trench to be examined, and not a second's delay is caused in the firing at the adjoining targets. It is not wise at Bisley to challenge the marking on the supposition that because the patch showing the position of a shot appears to be over the dividing line, it has perhaps touched the line. Nor is it worth while to invest half a crown, as the writer has sometimes seen done, if the marker has already pulled the target down and examined it on his own account, being in doubt as to whether or no it had been hit.

We give the conditions for the various classes of rifles extracted from the rules of the National Rifle Association for 1901. It will be seen that the work of the Association is twofold: it both tests the comparative skill of marksmen with the Service rifle and ammunition, and in the Match rifle class gives an opening for the experimental use within practical limits of various calibres and loads. Perhaps the most useful work of the Association has been that it has thus for forty years given an opportunity to all the world to test publicly improvements in explosives, projectiles, and arms, and has set up a high standard of accuracy in military shooting. The shooting with the Service rifle has from time to time brought out, both in arms and ammunition, points requiring attention.

RIFLES AND CARBINES.

The rifles and carbines allowed shall be classed as follows:—

Class I.

SERVICE RIFLE

·303 rifles as issued by the Government or of private manufacture, of *bona fide* Government pattern and bearing the Government Viewer's mark.

N.B.—·303 *Carbines may be used in S.R. Competitions instead of the rifle, as follows:—*

(a) *In single distance competitions in which the prone position is allowed.*

(b) *In competitions the aggregate of two or more distances in both or all of which the prone position is allowed, or in which one of such distances is 600 yards or over, provided the carbine is used at all the distances included in the Competition.*

All Service rifles must comply with the following conditions:—

1. *Weight.*—Including cleaning-rod, oil-bottle, pull through, and magazine—not to exceed the greatest weight of the regulation rifle of the corresponding pattern and mark.

2. *Length.*—Maximum, measured from the muzzle to the butt, when placed vertically on the ground, 49½ inches.

3. *Stocks.*—Must not be checkered. No pad or shoe for the heel-plate of the butt is allowed, nor may the butt-plate be checkered.

A metal fitting for the sole purpose of the attachment of a match back sight is permitted.

4. *Pull of Trigger.*—Minimum, 6 lb.

5. *Sights.*—Strictly in accordance with those on any pattern of Government Service rifle.

The only colours allowed on the sights are black or white or black and white, but not mixed so as to produce grey. No appliance may be affixed for the purpose of shading the sights.

Back sight:

(*a*) Must not be supported by any means extraneous to the rifle.

(*b*) The bar must not be capable of sliding laterally as a wind gauge.

(*c*) The bar may be reversed, and may be used on either side of the uprights; the 'small slide' authorised by Sec. 169 of the Musketry Regulations, 1898, may be used in all competitions not restricted to Service sights. Marks or lines of any kind, removable at pleasure, but not consisting of slips of paper or other substance capable of being shifted, may be used. Detached 'Verniers' or 'sight elevators' may be used.

6. *Handguard.*—The handguard may be removed at the option of the firer.

7. *Safety Catch.*—The safety catch may not be used for firing the rifle.

Class II.

MATCH RIFLES

Any breech-loading rifle complying with the following conditions :—

1. When of British make to bear proof marks both on barrel and breech.

2. *Weight.*—Maximum, 10 lb. In Magazine rifles the magazine, whether detachable or not, is to be included.

3. *Length.*—Maximum, 52 inches.

4. *Calibre.*—Maximum, ·315 inch.

5. *Stock.*—Full stocked and sufficiently strong in the opinion of the Bisley Committee for service purposes, and fitted with swivels for a sling. No pad or shoe for the heel-plate of the butt is allowed.

6. *Pull of Trigger.*—Minimum, 6 lb.

7. *Sights.*—Of any description, except telescopic or magnifying.

Class III.

SPORTING RIFLES

Calibre.—Any.

Pull of Trigger.—Minimum, 3 lb.

Sights.—Open sights, or such as have received the sanction of the Council or of the Committee. The Lyman back sight and the Beach combination fore sight have been sanctioned.

No lateral adjustment of fore or back sight will be permitted. The centres of both sights must be fixed over the centre of the barrel. If a platinum or other line is used on the back sight, only one such line will be permitted.

Spirit-levels are allowed.

N.B.—*Any single, double, or repeating rifle (whether of Government pattern or not) coming within the above conditions may be used in 'Sporting Rifle' Competitions.*

Class IV.

CARBINES

Any *bona fide* Government pattern of carbine of ·303 calibre, as issued by the Government, or of private manufacture and bearing the Government viewer's mark.

Pull of Trigger.—Minimum, 6 lb.

AMMUNITION

1. *Service Rifles and Carbines.*—Only Service ammunition issued by the N.R.A. at the firing-point shall be used, and no competitor may in any competition use any ammunition but that issued to him at the firing-point for that particular competition.

2. *Match Rifles.*—Any ammunition complying with the following conditions :—

(*a*) The bullet must be inserted in the cartridge case not less than two-tenths of an inch. Maximum weight of bullet, 217 grains.

(*b*) Maximum length of cartridge, 8·15 inches. Maximum diameter of cartridge at base, excluding rim, ·49 inch.

(*c*) When foreign Regulation rifles are used, the cartridge, if not within Regulations (*a*) and (*b*), must be, in every respect, of the dimensions of the Service cartridge proper for that description of rifle, and a sample cartridge must be previously submitted to and approved by the Bisley Committee.

3. *Sporting Rifles.*—Any ammunition.

In individual competitions it is well to remember that a prize won by the help of another, and not by a man's own skill and judgment, has not been fairly gained. However great may be the advantage of having a 'coach' or a friend to consult about the weather, someone who will say 'stop a bit,' or 'bide a wee,' if the flags begin to show a change of wind, it is not fair to the competitor (and there are many such) who fires alone, or to those who conscientiously respect the rule of no coaching which obtains at Bisley, to take advantage of such assistance. It is, of course, not always easy to draw the line. Someone firing close by makes a wide shot. One may speculate on the probability of its being the result of an unlucky change of aim, or of a sudden change of wind. It may possibly be the result of a careless aim. But the temptation to ask whether a change of aim was made, or how it was the shot went wide, should be resisted. Even the man who exclaims after making a 'magpie' that he put on 2 feet additional wind allowance, and that still it was not enough, is unduly helping the man who is to fire next. It is a natural tendency, arising far more from kind-heartedness than from a desire for reciprocity, which prompts many men to volunteer information or advice to those shooting with them. But this does not bring out the real merits of the shooters. When all the wits of a team are used to produce the best possible scoring for the team, co-operation is as important and as valuable as it is in cricket and in football, but when men are pitted one against another to decide who can do the best, their relative form must be obscured if they do not shoot with real independence. The object is to determine whether A. or B., as an individual, can make the biggest score, not whether A., with the assistance of C.'s advice, can make a better score than B. can, with the assistance of D., C. and D. being for the most part casual competitors who happen to be told off to shoot at the same target as A. and B., but whose judgment and skill may be quite unequal. This is the case in the competitions where squadding is arranged beforehand. But if we come to the shooting in unlimited entry competitions, there is still more inequality. It is pleasant and legitimate to shoot alongside a friend, and to exchange chaff over bad shots, or to speak on indifferent topics, only comparing notes when the shoot is over, and taking care neither to give nor to receive help while it is in progress. But sometimes friends will shoot together and systematically advise each other, who know each other's shooting, and who are accustomed to work together. This is fair enough if the rules of the competition expressly allow it, as in the prize for teams of two annually given by Mr. J. A. Doyle at Bisley. Otherwise it is extremely hard on the young or the solitary shot, who finds that he is within a point or two of the highest possible score, and has missed it only because he had not somebody at his elbow to see that he did not pull the trigger just as the wind changed. The writer himself feels strongly that a score made in an individual competition with assistance is neither fair nor creditable; but he has often found others expecting as a matter of course to give or receive assistance. The Continental system of squadding, in which not more than one competitor shoots at a target at the same time, has one advantage, that the shooter is isolated during the series of shots.

There are other matters in which it is less easy to draw the line between absolute fairness and the taking of small advantages. The theory at Bisley at all events is that the firing-points are flat, and that they are the same for everybody. The man who manages to work a deep hole for the toe of his right foot, for use in the kneeling position, certainly has some advantage over the man by his side firing off a smooth and flat piece of ground. The objection is not so much that the one competitor does something which is unfair in itself, as that he introduces a condition which cannot be equally applied to every man firing. Even in such matters as putting a thick handkerchief, or pad, under the coat, to help support the left arm in shooting standing with the arm leaning against the chest, questions of strict fairness begin to arise. There is only one safe rule—to abstain from everything that borders upon the line of questionable dealing, and to be restrained by proper pride from 'sailing near the wind.'

The rather elaborate code of regulations under which the National Rifle Association's and other public competitions are conducted is directed to no other end than to secure, so far as possible, a complete equality of treatment between all competitors, and to eliminate opportunities for fraud. The more delicate questions, on one or two of which we have touched, depend rather upon the individual good feeling and good sense of the competitors. It must be remembered that where some unfair practice is noticed, it does no good to grumble because so-and-so is breaking the rule, or taking a mean advantage. The Executive has little opportunity of detecting and dealing with such cases unless those who happen to see them have the moral courage to come forward, and to bring the offenders to notice. The exposure of the marking swindle at Wimbledon in 1880 was due to Private Runtz, of the London Rifle Brigade, who boldly undertook the unpleasant task of showing it up in public, and who deserved, and has received, the appreciation of a long succession of shooting men.

If team shooting lead, as it does, to the highest and most interesting results, owing to the co-operation of skilled shots, the responsibility which rests upon the captain of a team is all the greater for it. He cannot expect to obtain satisfactory results if he have not a free hand in selecting his men. The system of filling the places in a team absolutely by the scoring made at certain previous individual competitions is generally recognised to be unsatisfactory. It does not follow that a man will have maintained up to the day of the match the form on which he gained his place, and yet it may be difficult for any candid friend to persuade him that he ought not to shoot. The captain himself must command the entire confidence of the members of the team, and his authority be quite unquestioned. He should not himself be a shooting member of the team, for if this is the case (although exceptionally the arrangement works unobjectionably) there is always a tendency for it to be thought by those to whom he has not given places in the team, that his judgment may have been biassed by an undue belief in his own powers of shooting. It is only if the captain himself is fortunate enough to be generally recognised as among the few foremost shots, and to maintain this reputation in the match, that he is beyond criticism in the matter. The captain who has put himself into a team and then makes the bottom score, is in a position not to be envied. No wise captain will himself shoot in a team unless previous form makes it quite clear that he would otherwise have to put in a man obviously his inferior. In matches of the first class, whether with the military rifle or the match rifle, most men find their nerves, especially when shooting the first time, much more tried than when shooting individually for prizes, for each man is not only a representative of his club or of his nation, but he knows that if he should do badly and lose the match for his side, there will be a black mark against him which it will be almost impossible to efface. It has often happened that a man who as an individual shot has been doing brilliantly, has failed to his own disappointment, if not to the disaster of his side. Many a man has had the edge taken off his usual night's rest by the consciousness that he was to be included in one of the International matches next morning, and has shot none the better for it. For this and other reasons the writer holds that a 'benevolent despotism,' exercised with judgment and fearlessness, as well as with tact, is the best form of government for teams. The man who turns nasty because he thinks on the form which he has shown that he ought to have been put into a team is exactly the man who, if he should win his place in the team by competition, would decline to give way even when told by those competent to judge that he was now shooting in much worse form, and ought to make room for another. The difference between a good team shot and a bad one is very marked; fussiness, nervousness, noisiness, these are all grave disadvantages to the other members of the team during the progress of a match. The ideal team shot is the man, not of no nerves, for the man of no nerves rarely does anything brilliant; but he whose self-control is complete. He is ready at the last moment to go out of the team cheerfully if he finds reason to think that he will not do himself and his team credit, either from want of form in himself, or from such want of confidence in his rifle as the vagaries of the weapon will sometimes induce. Whether in or out of the team, he will be ready to give any help in his power to others to make a success of the match. No wonder that such men are again and again selected to shoot in teams in preference, *cæteris paribus*, to young shots whose nerves and dispositions are to a large extent an unknown quantity. The organisation of coaching, too, is the captain's business. This, with short-range teams, is not very serious. The rather casual team, which in many matches is the only kind which can be got together, of men of high skill individually, but unaccustomed to work together, though each capable of doing well in his own way, admits of little assistance beyond careful watching to warn the firer against any change of wind, and the formation of pairs by telling off to shoot together the men who will work well together. When all is said and done, however, there remains much of uncertainty in a team match. Sometimes almost inexplicably the rifles go wrong, or the form of the men is disappointing, and it may happen that an unorganised concourse of individuals will beat an organised team, even when man for man they are in no way superior. The result of team matches under field-firing conditions at unknown distances is even more uncertain. Teams often find it difficult to practise for them at home, and the trouble and expense of specially coming a long distance often restrict competition to those living near at hand. All the teams cannot shoot at once, and the distances for firing, which are unknown to the first team, are apt to become known to those who fire later. This cannot be avoided without otherwise interfering with the equality of conditions. Such difficulties as these account for the great preponderance at Bisley and elsewhere of competitions at fixed distances and for individuals.

CHAPTER XIX

DR. CARVER'S FEATS—TRICK SHOOTING—RAPID FIRING AT WIMBLEDON AND ABROAD—HERRMANN'S PERFORMANCE—CAPTAIN OTTER'S SKILL—NATIONAL RIFLE ASSOCIATION RAPID COMPETITIONS—SKILL IN THE RIFLE BRIGADE—A FEAT OF MR. LANCASTER—RESTS AND REST SHOOTING—DIAGRAMS OF ABNORMAL MERIT—BEST SHOOTING IN AMERICA—UNCERTAINTY OF RESULTS—SAMPLE DIAGRAMS MADE AT 50 YARDS—AND AT 100 YARDS—WALLINGFORD'S SHOOTING AT 300 METRES—RECORDS OF THE QUEEN'S PRIZE—MATCH BETWEEN E. ROSS AND FENTON—THE ANY RIFLE ASSOCIATION CUP—THE WIMBLEDON CUP—TARGETS BY RIGBY, MELLISH, AND HALFORD—GIBBS'S RECORD SHOOTING—PUBLIC SCHOOL AND UNIVERSITY SHOOTING—THE NATIONAL CHALLENGE TROPHY—THE ELCHO SHIELD—MATCHES WITH AMERICAN TEAMS, 1874–1883—MATCH AT THE HAGUE, 1899

Probably the rifle-shot whose name was best known to the English public in the latter years of the nineteenth century was Dr. Carver, the American. Immense skill of manipulation of the Winchester rifle, very great rapidity of aiming, and an extraordinary knack of hitting moving objects, were the great features of his exhibition performances twenty years ago when he visited this country. He would break a glass ball thrown into the air by his black servant with considerable certainty, and he would hit small coins similarly thrown up. So dexterous was he in the use of the Winchester rifle that he could fire two shots at a glass ball while in the air, missing it purposely, and break it with the third before it touched the ground. He was a man of fine physique, and his powers of endurance were remarkable, as was shown in July 1878, when he broke 5,500 glass balls in 500 minutes at the Brooklyn Driving Park. His feats of fancy shooting were unmistakably the result of great natural powers, well developed by constant practice. But it does not appear that Dr. Carver showed any very unique skill under the ordinary conditions of rifle shooting at ordinary distances. Other trick shooters have from time to time appeared, usually on the stage of the music-hall. It must not be supposed that these performances are either as marvellous or as practical as they at first sight appear to be. Dr. Carver used the rifle exactly as the shot-gun is commonly used, with both eyes open, and shooting more by the sense of direction than by alignment of the sight. A ball thrown up is practically stationary for an instant before it begins to fall, and when the knack of firing quickly has been thoroughly acquired, it is by no means so difficult to hit as might be supposed, while a graze will break it. If the diameter of a glass ball is 3 inches, and that of the bullet ·5 inch, the mark presented at a distance of ten yards by the glass ball will cover an angle of fully 33′. That is to say, it would be equivalent in area to a circular target 6 feet in diameter at 200 yards distance, whereas the ordinary Bisley target is a square one measuring 4 feet each way. That we may not be supposed to be unfairly depreciating this class of shooting, Mr. Theodore Van Dyke may be quoted, who, in his excellent book on American hunting, 'The Still Hunter,' devotes a short chapter to 'The Rifle on Moving Game.' He speaks of having foretold in 1878, when Carver's shooting fame first astonished America, that he would in a few months have plenty of successful imitators. His prediction was fulfilled. He says: 'Imitators by the score arose, most of whom have excelled the best records made by Carver during his first six months of glory. And before long we began to hear of wonderful boys, and even wonderful girls, that hit glass balls and pennies in the air with a rifle. These prodigies are on the increase. The other day I read of two new cases in one paper, neither over ten years of age.' The fact was that instead of being marvellous the performance was simply new. He disposes of the fallacious talk about wing-shooting with the rifle by pointing out that Dr. Carver and all his imitators 'have in all their public exhibitions been careful to shoot at no *pigeons* or other *birds* on the wing, to shoot at no balls tossed *across* the line of fire or *at any angle to it*, and to shoot at nothing in motion when at any distance where it would require the most ordinary amount of skill to hit the same object if at rest.' The degree of skill, he points out, necessary to hit a 3-inch ball at ten paces is absolutely useless in the field. He mentions that Mr. Maurice Thompson at the first trial broke with a bow and arrow thirty-five balls out of fifty tossed into the air at ten paces, shooting as fast as he could, the feat being much more difficult with the bow and arrow than with the rifle. As regards the throwing up of pennies instead of glass balls, he points out that it is much easier to hit a 1-inch mark at ten yards than a 3-inch mark at thirty yards, and that the champion rifle wing shots always prefer balls to pennies, although they are more than twice as expensive and more troublesome to handle. Dr. Carver was certainly one of the best rifle-shots in the field before he began to give exhibition performances, but the account given by himself in the Chicago 'Field' of November 20, 1880, and quoted by Mr. Van Dyke, of his shooting chamois and deer, does not suggest exceptional skill. Shooting at moving objects with the rifle, always provided that circumstances allow it to be done with safety, is excellent practice for giving quickness and handiness; but it is important to take shots moving in all directions, and not only those going straight away, or straight across at a fixed distance. The exhibition shooting of which we have been speaking is always done at such distances that neither the fall of the bullet nor the time which it takes in flight amount to anything material, but this is not at all the case in the field.

In the first twelve years of the Wimbledon meetings prizes were often given for rapidity of firing under varying conditions with the object of developing the invention of practical breech-loaders, or of cultivating rapid loading, and loading when on the move with the Service rifle. A favourite form of competition in vogue thirty years ago was a combination of shooting and running on the following principles: The competitor came to the firing-point with a loaded rifle, and when all was ready the word 'Commence' was given, at which he capped, fired, loaded, and fired again, and then had to carry his rifle, ammunition, loading-rod, &c., round a post 50 yards away, loading, if he chose, while running. Returning to the firing-point, he fired two more shots, ran round the post again, and so on, for the three, four, or five minutes laid down as the limit of time. Such a competition excites a good deal of interest, and is of a practical nature. At the same time success depends so much upon specialisation and practice that it is apt to fall into the hands of a small circle who specially cultivate the particular drill necessary, and so to lose in popularity and general utility. Rapid-firing competitions for breech-loaders were also held, and elicited much interest. In these the firing was generally of an unlimited number of rounds in a limited time, where any position was allowed. Some wonderful results were arrived at by constant practice and the use of the sling to steady the rifle. Such prizes were a great feature of the Wimbledon meeting of 1870, and some remarkable shooting was registered. With the Henry rifle (not the Martini-Henry) Mr. Farquharson, in firing at 200 yards for two minutes, made fifty-two hits and no misses. In a similar competition for squads of four men, firing independently for three minutes at 200 yards, a Scotch squad, using the Henry, fired 192 shots and made 163 hits; and an English squad, using the Martini-Henry, 195 shots with 155 hits. This is a very good average of rapidity. In 1871 the number of shots was limited, but in 1872, in a competition for a rapid-firing prize similar to that already described, squads of four men firing for three minutes at 200 yards, some remarkable shooting was made with the Soper rifle. Four men of the 1st Berks, Sergt. Soper being one of them, fired 338 shots, of which 306 were hits, the best individual performance being that of Private Gilkes, who fired 97 shots and made 95 hits. No other squad entered against this one. The average of twenty-eight shots per man per minute, and of twenty-five hits, shows an extraordinary quickness of manipulation, and a well-made breech action working without any sort of hitch. The firing must have been almost without aim, and have depended upon the rifle keeping its general direction when used in the back position. Presumably after this time it was thought that the greatest possible speed of single-loading rifles had been reached, and that there was nothing to be gained by continuing such competitions.

Rapid-firing competitions on the Continent have usually followed somewhat different lines. Dr. W. H. Doer, of Zürich, kindly supplies the following particulars of a match which was shot there under his personal supervision in 1888. The object was to have a long competition which should combine rapidity with accuracy. The rifle used was the single-loading Martini, the distance 300 metres (328 yards), and the object to make in as short a time as possible 200 hits on the carton of 38 centimetres (14·96 inches). The award of merit was determined by the average number of cartons made per minute. There were thirteen competitors, and much the most remarkable performance was that of Emil Herrmann, who fired kneeling, and used two rifles with the Martini breech action, having hair triggers, which were then fitted to the Swiss regulation arm. He succeeded in making the 200 hits in 36 minutes 57 seconds, firing in all 430 shots, his percentage of cartons to shots being 46·5, the average number of shots per minute 11·09, and the average number of cartons per minute 5·4. But although this performance was approached by no other competitor, he improved upon it considerably in a second attempt, making the 200 cartons in less than half an hour (29 minutes 45 seconds) out of only 388 shots, the percentage of cartons being 51·55, the shots per minute 13·04, and the number of cartons per minute 6·69. So good was his shooting that he hardly ever missed the bull's-eye of 60 centimetres (23·6 inches).

Rapid shooting of this kind is an art in which practice is of great value. The power of manipulating the rifle, of loading and firing without fumbling, is by no means a gift of Nature. In a long series of shots with a single-loading rifle giving a heavy kick, the exertion of taking the recoil is great, and the labour of loading and extracting is also exhausting. The heating of the barrel in rapid firing makes a mirage which adds immensely to the difficulty of accurate aiming. One of the great drawbacks of competitive firing under such conditions with black powder was the interference of smoke from the firer's rifle, or that of someone shooting close by. This trouble no longer exists. There are two other difficulties which prevent practice of this kind from becoming popular. The first is the great expenditure of ammunition, which entails considerable expense, and for most men limits the possible amount of practice; and the second, that if a large number of shooters compete alongside each other, at targets placed in a row, it may be regarded as a certainty that someone or another will trespass accidentally upon his neighbour's target, and thereby interfere with the proper record of the scores.

It is doubtful if Herrmann's performance has ever been surpassed under like conditions. The additional speed of shooting given by the use of the magazine and loading from a charger may be illustrated from the best performances of Captain Otter, one of the shooting instructors of the Swiss army, who has made a special study of rapid firing. Starting with a loaded Swiss Service rifle, with its straight-pull action and full magazine of thirteen cartridges, he can make at 300 metres (328 yards), on the regulation target, 1·8 metre square (5 feet 11 inches), from 36 to 39 hits in as many shots during the space of one minute, whether from the knee or lying down. His average score will be just about three points a shot, the target being divided as follows :

Carton,	40	centimetres (15·7 inches)	counting	5 points.
Bull's-eye,	60	" (23·6 inches)	"	4 "
Centre,	1	metre (3 feet 3·4 inches)	"	3 "
Outer ring,	1·50	" (4 feet 11 inches)	"	2 "
Remainder of the target			"	1 "

This shooting may be considered to correspond closely with firing at the same rate of speed at 200 yards and putting half the shots in and half out of a 2-foot circle, and all within the limits of a 4-foot target.

At 200 metres (218 yards) Captain Otter can in twenty seconds fire ten to thirteen shots, and make 80 per cent. of hits upon a row of five figure-targets representing kneeling men, often hitting each one two or three times. At the same distance, from the knee, in one minute, shooting at a row of thirty similar targets, he can fire thirty shots and make twenty to twenty-five hits on the same number of different figures. Or, shooting kneeling at a row of expanded bladders to represent heads, he has in two minutes fired fifty shots, and with thirty of them broken thirty of the bladders. Firing for the quick-firing prize at the International Meeting at Albisgütli in 1899, he fired 100 shots in 5 minutes 59 seconds at 300 metres (328 yards), and made eighty hits in the black bull's-eye, 60 centimetres (23·6 inches), taking the first prize.

One of the most practical competitions at Bisley is that now known as the 'Pixley,' which has existed for more than ten years. Prior to 1897 it was fired with the Martini-Henry rifle, the time allowed being one minute, during which ten shots were to be fired at 500 yards at the ordinary Bisley second-class target with 2-foot bull's-eye. In four of the seven years (1890–96) it took a score of 46 out of a possible 50 points to win the first prize, and in 1893 and 1895 the winning scores were 47 points. In 1897 the conditions were altered to suit the ·303 rifle, eight shots being allowed from the magazine, and the time limit being reduced to thirty seconds. Out of the possible 40 points which could be made if all eight shots were bull's-eyes, two competitors, Lieutenant Etches and Sergeant-Instructor Wallingford, made 39 in 1899, and the winning scores in the other three years were 38, 37, and 36. In 1901 no higher score than 33 was made, owing to the reduction in the divisions of the target. It is noticeable that in this competition the same names tend to recur in the prize list, and it seems to become the special province of certain shooters. The same is the case at the running deer, where De Grey, Loder, Cairns, Ranken are names which have at different times stood almost alone, as that of Winans has with the revolver.

The same may be said to some extent of the prize now called the 'Wantage.' This is a competition of a most practical kind. It is fired at 200 yards, and the target is represented by a disc 18 inches in diameter, painted a light blue up to 1900, when the colour was changed to khaki. In the centre of the target is a circle 8 inches in diameter, which counts 3 points, the rest of the disc counting 2. Any position is allowed. While the Martini-Henry was used (1893–6) the target was shown for five seconds, and disappeared for the same time, to give an interval for loading; seven shots were allowed, and the winning scores varied from 19 to 21 out of a possible 21 points. With the introduction of the ·303 rifle in 1897, the number of shots was increased to eight, and the time of appearance and disappearance decreased to three seconds. In each of the two years, 1897 and 1898, one score was made of 23 points out of a possible 24; in 1899 five scores of 23 were made; in 1900 three such scores; and in 1901 one full score of 24 points and four of 23. Major Cowan, R.E., Lieutenant Etches, Mr. E. J. Rigby, and Sergeant-

Instructor Wallingford are amongst those whose names occur most conspicuously in the rapid-firing competitions we have been describing. It must not be forgotten that in this competition, and the rapid-firing competition at 500 yards just described, the shooter is at considerable disadvantage as compared with deliberate firing, because he may be making an extremely close group of shots to one side or other of the bull's-eye, but has no opportunity of correcting his aim, because the shots are not marked. But it is quite evident, not only to those who watch the scoring of other people, but to those who by way of experiment enter a few times in these competitions, without having given much attention to practising them, that the scoring made when firing at a reasonably rapid rate is surprisingly better in proportion than that made in deliberate shooting. The fact is quite indisputable, and the moral to be drawn from it seems to be that habitual quickness in aiming is really no disadvantage even in shooting when deliberation is allowed.

Before dealing with the records of a few of the principal deliberate competitions, both for individuals and teams, which have taken place since the revival of the Volunteer movement, one or two instances of feats with the rifle before that time may be given.

The following anecdote of Lieut.-Colonel Wade, commanding the 2nd Battalion Rifle Brigade, formed May 6, 1805, is told by Sir William Cope in his 'History of the Rifle Brigade.' 'Lieut.-Colonel Wade,' he says, 'was an admirable shot with the rifle himself. He and a private of the name of Smeaton used to hold a target for each other at 150 yards; and it is said that he and John Spurry, a private in the regiment, held the target for each other at 200 yards: a wonderful feat, while the Baker rifle was still in use. There used to be a story of him at an inspection by the old Earl of Chatham, who expressed a wish to see some practice with the rifle; and having made some remark on the danger of the markers, Wade said: "There is no danger"; and calling one of the men (no doubt Smeaton or Spurry), bade him hold a target, and he himself taking a rifle fired and hit it. Lord Chatham's horror at this was extreme, on which Wade said: "Oh, we all do it." And bidding the other to take a loaded rifle, he ran out himself and held the target for the soldier's fire. Probably no other men in the regiment but themselves could have done this. Colonel Wade, C.B., died February 13, 1821, having retired from the army.'

To show how good the best rifles of 1840–50 were, as well as the skill of the expert shots who used them, we cannot do better than refer to Mr. Scrope's well-known book on deer-stalking. He quotes a letter from Mr. Lancaster, the gun-maker, who says: 'I shot a match last year (1845) for Mr. Graham at 300 yards, firing from the shoulder without a rest, he backing me to hit a bull's-eye 8 inches diameter six times out of nine. I hit it six times following, and averaged three bull's-eyes in five shots during the last forty-five rounds. In fact, I have done more at 300 yards with the cone than I ever did or saw done at 200 yards with the spherical ball.' This rifle fired a short conical ball, and was a 16-bore; the grooving was presumably the 2-groove oval, which is still the speciality of this firm, and had a spiral of one turn in 11 feet. The performance is a remarkable one, especially from the position used, and must have been made under the best of conditions. Yet it cannot have been abnormally good, since the match was undertaken on a knowledge of what could be done by Mr. Lancaster.

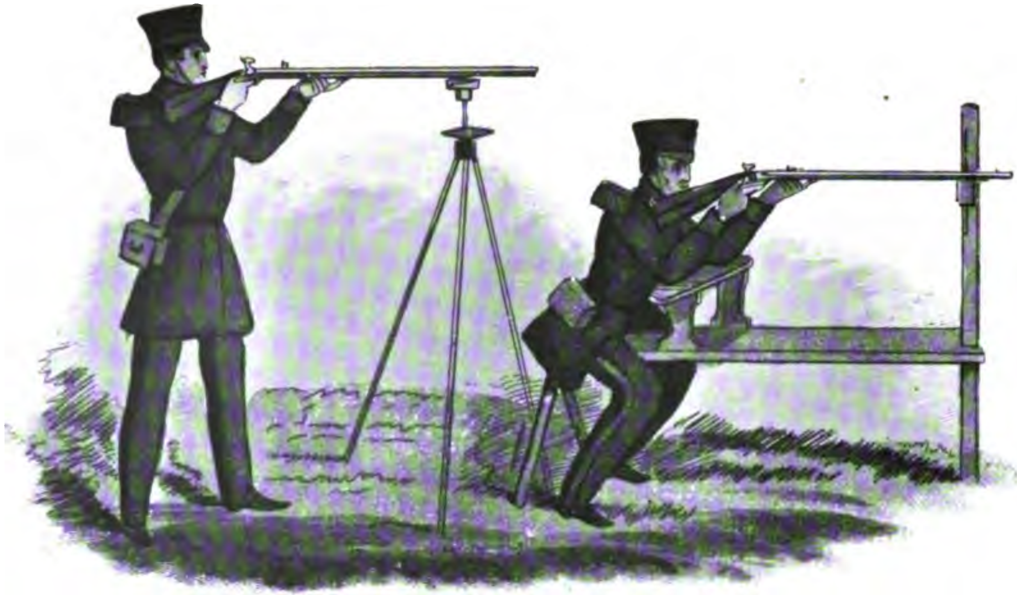
Making fine targets from a rest is an amusement popular in certain circles in America, but it has never had any vogue in this country, although gunmakers usually find it convenient to have some kind of rest on their ranges to use in sighting rifles. The most satisfactory form of rest, perhaps, is of table height, with a raised part at one end high enough to support the barrel of the rifle, while the shooter's elbows and body rest on and against a lower part as on a table. The rest may be something of a fixture if it is only to be used on one range and at one distance. Its feet may be posts driven into the ground, with cross pieces and a heavy plank between them. A four-legged rest is very steady, if the feet are well spread and one pair of the legs can be adjusted independently of each other. The height of the rest can to some extent be regulated if all the legs are hinged so as to be arranged more or less upright. Such a rest can be made to fold into quite a small compass, as the legs fit alongside the body of it when folded up. Three-legged folding rests have also been made in America, and are convenient enough. Shooting with a rest demands great care. The barrel of the rifle must always be supported evenly, and with equal pressure, in the same place. The pressure against the shoulder must also be regulated so as not to vary. The shooter's body should be well supported while he is firing, so that there may be no question of movement of the muscles which balance it. Similarly, in firing from a rest arranged for the standing position, the weight of the body should be leaned forward against the edge of the table. It is well to have some arrangement by which the elbows may be supported at the proper height in relation to the rest; either the rest for the barrel should be adjustable in height, or else there should be some means of packing up that part of the table on which the elbows bear. If the table is the right height for the elbows without packing, it will be worth while to make little hollows in it, in which the elbows may be supported without slipping. Plate LI shows the kind of positions used in firing with rests, standing and sitting, and has been taken from Ackermann's little book already referred to. The probability is that it is better to rest the rifle rather further from the muzzle than is here shown. The table giving the rest for the elbows and the rifle should at all events be detached from the seat upon which the firer sits.

Such rests as these differ entirely from the mechanical rest, in which the rifle is held so that it slides back with the recoil, the object here being to fire a series of shots without having to readjust the aim. This is the best means of testing ammunition or rifle barrels where, as in factories, it is necessary to do so in quantity, but the shooting is quite independent of any alignment of the sights. The different way in which the rifle is gripped in a mechanical rest destroys the normal vibration of the barrel produced in firing from the shoulder. It has been found at Enfield that rather closer shooting can be obtained from the mechanical rest with the ·303 carbine than with the rifle: this fact is apparently referable to there being less variation in the vibration of the shorter barrel, when clamped in the rest, than of the longer, and does not indicate any superiority when fired in the ordinary way. Colonel Watkin, the able head of the Enfield Small Arms Factory, has devised a mechanical rest which supports the rifle in such a way that it shoots accurately to the same sighting as when held by a man of average physique. This should prove very useful in testing and adjusting the sighting of rifles. It has the great advantage over shooting with direct aim from the shoulder that when once sighted a series of shots can be fired very rapidly and with perfect accuracy without relaying the rifle, thus saving both time and trouble.

The very fine diagrams which have been produced at different times in America in rest shooting have usually been made from table rests at a short range, generally at 200 or 220 yards, well flagged, the shooter allowing ample time for his rifle to cool between the shots, and, if necessary, waiting patiently until the wind should come again exactly as it was for the previous shots. The virtue of patience is very necessary, and it will be found that time after time a good series of shots is spoilt by one or two which diverge from the close group in the centre, while it is only at rare intervals that such a target can be obtained as is fit to be framed and glazed. It is this class of shooting, in which there is no objection to hair triggers, barrels of unpractical weight, and telescopic sights affixed to the rifle, in which, in fact, any and every appliance that may possibly improve the shooting is allowable, that proves most clearly of what the rifle is, and of what it is not, capable; and the man who has some experience of it will have learnt, among other useful lessons, that there are certain occasions on which the marksman shooting under ordinary conditions is not to blame for a shot which goes wide. It will be found, too, that some rifles, from causes quite difficult to explain, will as a rule make much closer groups than others, and that variations in the load sometimes affect accuracy very much.

In speaking of rest shooting we have said that there is no certainty of obtaining a very good result from any given

PLATE LI



VOLUNTEERS FIRING FROM RESTS, 1861

group of shots which may be fired. There seems always to be a large element involved of what may be called luck, if for the whole series of shots things should go perfectly right, without anything abnormal happening. Nevertheless it is undeniable that the longer the series of shots, the truer is the test of the capacity of the rifle and of the man. Shooting with the rifle supported by a rest has never been systematically practised in this country, but in America it has been sufficiently cultivated to afford a very good measure of what work is possible. The standard number of shots recognised there is ten. For five or even seven shots the chance of all going without a hitch is, of course, much greater. The writer recollects once in firing with a Mannlicher rifle and match sights at 200 yards, in a fresh cross wind, putting four consecutive shots into a space of less than 1 inch by ¾ inch., on the little cardboard target which was used. This was in the course of some experiments to ascertain the angles of elevation at short, mid, and long ranges. This little group was perfectly abnormal. The conditions of weather were such as to render it an absolute fluke, but although it was not in the bull's-eye of the little target, it would have looked very striking if presented as a performance at 200 yards, for, as it happened, a few other shots fired at the same time were not so close to the little group as to spoil it. The writer does not care about taking a less series than ten shots as any test of a rifle, and, indeed, this number by no means forms a conclusive test. Sir Henry Halford used to tell of a Metford Match rifle which was supplied to a friend of his many years ago, and which was delivered by the maker in much doubt as to its success, since by accident one groove had been rifled rather deeper than the others. The first series of shots fired with this rifle, 15 shots at 900 yards, made a quite unusually good group. The owner was delighted with it, and the question began to arise whether there might not be some hidden virtue in having an odd groove of extra depth in the barrel. The same rifle was shot many times afterwards without making a respectable group or score, and before long had to be discarded. The writer recollects when at Oxford watching the shooting of a young shot who had recently left school, and who was using a Snider taken from the rack in the armoury, the interior surface of its barrel being much damaged by rust. It was a weapon which no careful marksman would have taken to the range to make a score with, but after beginning with a score of 28 out of 35 at 200 yards, he made the full score of seven bull's-eyes, 35 points, at 500 yards; and at 600 yards, 34 points, scores which with a Snider rifle were entirely exceptional, and in fact, quite beyond the normal power of the weapon; nor was the shooter's subsequent record upon the rifle range at all distinguished.

This fact of the somewhat accidental character of the best performances which can be got from the rifle is very noticeable in trying to make close diagrams. Mr. Gould, who wrote upon modern American rifles before smokeless powder was in general use in rifles, states his belief that 'there are but few, if any, rifles which, combined with factory ammunition and the uncertainty of the shooter and weather conditions, that will shoot fifty consecutive shots into an 8-inch bull's-eye at 200 yards, shooting with rest and telescope, or any style of sights.' The details given by Mr. Gould of the best performances within the range of his experience are very interesting. The usual distance for rest shooting is 200 yards, and the American Standard target (see p. 423) is subdivided, as before stated, within the 8-inch bull's-eye into circles as follows:—The innermost circle, counting 12 points, is 1·41 inch in diameter, the next circle measures 2·33 inches, counting 11; the next 3·36 inches, counting 10; the next 5·54 inches, counting 9; while the remainder of the 8-inch bull's-eye counts 8 points. In a very wide experience of rest shooting, extending over twenty years, and comprising an intimate knowledge of the performances of the most expert rifle-testers among amateur and professional shots in America, Mr. Gould says that he has never yet seen fifteen shots placed consecutively in the 12 circle, twenty shots in the 11, forty shots in the 10, sixty shots in the 9, or one hundred shots in the 8-inch bull's-eye; while he mentions that at the time when his book was written nearly one hundred clean scores of ten bull's-eyes had been made at 200 yards in off-hand shooting, that is, in shooting standing without a rest. He adds that no one has shooting standing been able to place ten shots on or within the 10 circle ; nor, in shooting from a rest, has the feat ever been accomplished of putting all ten shots within the 12 circle. He says :—'It is considered brilliant shooting to place ten shots in the 11 circle at rest, and the same number in the 10 circle is very fine work. . . . Five shots in the 12 circle have no special value ; seven shots

FIG. 97

are more difficult and wonderful ; ten shots never yet attained, and beyond that the difficulties of the task are rapidly multiplied, and seem at the present time almost among the impossibilities.' Mr. Gould's book is admirable in its full knowledge and sensible treatment of rifle matters; and it is, so far as we know, the only book dealing at all adequately with this particular phase of the subject. We venture, therefore, to borrow from it an illustration (fig. 97) showing a target of exceptional merit made in rest shooting at 200 yards, reproduced full size, and consisting of a series of ten shots. It counts 118 out of a possible 120 points, there being only two shots which do not touch the border of the 12 circle. One of the shots is certainly a lucky one, as it does not completely break through the white line. This, of course, represents quite exceptional work at 200 yards. The uncertainty of the results is described by Mr. Gould as follows:—'I have seen targets of ten shots which could be touched or covered with a silver dollar, which were shot at a distance of 200 yards, and later the same rifle, ammunition, and man, shooting at the same distance and place, would not be able to shoot into an 8-inch bull's-eye; and mark you well, brother riflemen, I have seen this with breech and muzzle-loading rifles; rifles weighing twenty pounds, fitted with telescopic sights and shot from machine-rest, as well as the ten-pound breech-loading rifle fitted with the usual target sights. Later these same rifles would shoot with astonishing fineness but intermittingly, that is, unless the rifleman had concluded the rifle had shot out and disposed of it. I have seen targets shot by experts of the rifle factories which would take a circle 10 or 12 inches in diameter to enclose the shots, and the next group be in a 3-inch circle; the latter would perhaps be sent to a customer with the rifle, and the value of the arm based on the best target. Ten shots usually constitute a score, and the fine work done indicates the excellent shooting qualities of American rifles, perfection of ammunition, and skill of the marksmen. Several times this number of shots have been placed on or in the 11 circle of the Standard American target when shooting from a rest, but this is no evidence that a rifle is capable of shooting continuously into so small a space.'

As Mr. Gould says, the exceptionally good targets which are often paraded to give the public the idea that they represent normal performances are frequently those picked from dozens, if not hundreds, of targets made, and the public accepts the abnormal for the usual. There is no interest in looking at a large number of rather inferior records, but if an extraordinarily fine score can be shown as having been made with a particular rifle, that score is quite sure to be assumed by the average man as representing a typical performance with it. Mr. Salem Wilder speaks of the necessity for caution in accepting records without some good evidence, and of unscrupulous folk who are capable of representing a diagram as having been made at 200 yards, when it really was made at 100.

Even where the score or diagram has been genuinely made, the tendency to argue from the particular to the general is, as always, very dangerous. Those who used the Snider rifle were only too familiar with the feeling of helpless bewilderment which would come now and again when, as Major Young puts it, the rifle would 'utterly refuse to obey the helm,' when a sudden string of misses would begin, or wild shots occur, with no reason whatever so far as the shooter could tell either in his own manipulation or in the circumstances of weather and light. We have better military rifles now, and are comparatively free from such complete breakdowns; but there remain variations of circumstances which we cannot as yet altogether fathom, and which, quite independently of the skill of the man, will sometimes bring an unaccountable miss, or, what we never hear of, though it happens sometimes, an unaccountable bull's-eye. These causes will produce now a group of shots of exceptional merit, now one scattered much more widely, and perhaps spoiling a score even more because each shot misleads the shooter into correcting his aim, on the assumption that it was a normal one, than because of the actual divergence of the group made. It is worth while to give a few examples of groups of shots made at short ranges without the help of a rest, to show the standard of accuracy that may be expected when all goes well. An example of shooting with the

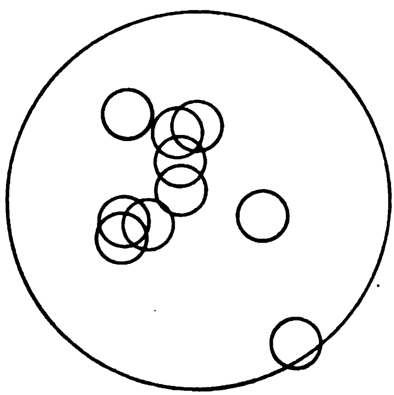


FIG. 98

·303 Service rifle and ammunition is fig. 98, which shows ten shots, at 50 yards, fired in August 1892, with cordite cartridges. This was the best of three or four targets fired consecutively by the writer. With the present ammunition there should be little difficulty in producing a better diagram than this at the same distance. Fig. 99 shows ten shots at the same

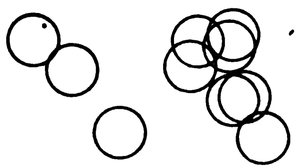


FIG. 99

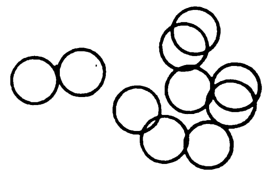


FIG. 100

distance (January 18, 1894), with an experimental load of cordite made up in a rather different form. Fig. 100 shows another diagram of ten shots at 50 yards with the ·303 (May 15, 1894); in this case cannonite powder was used. This is a very good diagram, and on the strength of it the load was taken to the 1,000 yards range, where it at once gave excellent shooting. These diagrams were made in the back position, the rifles being fitted with Match sights. A very good diagram of twenty shots at 50 yards made in the 'Field' trials of 1883 by Messrs. Holland's rook rifle of ·295 bore, fired from a rest, is shown in fig. 101. The performance came at the time almost as a revelation of the shooting which such a rifle would give if carefully made and sighted, and fired with the best ammunition. Diagrams as good, and better, have since been made with rook rifles, but we believe that a result of the performance of this and other rifles of Messrs. Holland in the 'Field' trials was that the general standard of accuracy in this and other classes of sporting rifles was materially raised.

FIG. 101

Attention has already been drawn (p. 143) to the remarkable diagram of five shots made at 100 yards by Mr. Littledale with a Mannlicher, and to the 'record' score for the Martin Smith prize for seven shots at the same distance. We now give (fig. 102) a diagram from the pages of the 'Field' of ten shots at 100 yards made in October 1899, with an oval-bore ·256 rifle made by Charles Lancaster. This is a performance above the average, and another of about the same standard is shown in fig. 103. This was made with a foreign ·256 rifle without a rest by the writer, shooting for 'group,' and not for the centre of the bull's-eye. It was made with a sporting bullet, with the lead exposed at the point, and was the best of several shoots fired in trying two or three patterns of bullets against each other in August 1898. Shooting of this order of merit does not compare with the highest accuracy which has been obtained from rifles at 100 yards, but it is very easy to make worse shooting with rifles and ammunition of this class. These groups look large on a page: at 100 yards they look very small. Fig. 104 is a diagram at 100 yards made at Highland by Colonel Bodine, the well-known American shot, on November 7, 1878, with a Borchardt rifle, cleaned out between the shots and firing a bullet of 550 grains. It was made from the back position, and is exceptionally close. Figs. 105 and 106 appeared in 'Forest and Stream,' March 27, 1884, being sent by a correspondent 'E. A. L.' They were made in March 1883, also from the back position, and without cleaning the rifle, the fouling being moistened by breathing into the barrel. The rifle used was a ·4 Maynard rifle. Fig. 105

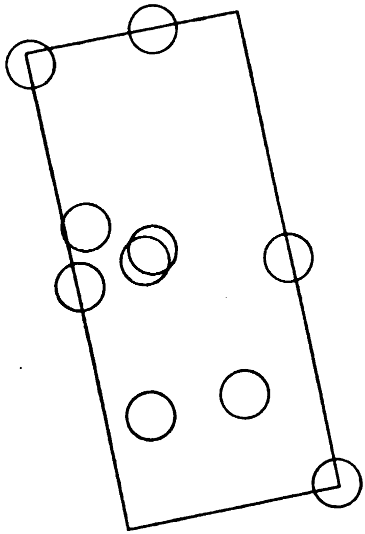


FIG. 102

consists of ten and fig. 106 of forty consecutive shots, the intersection of the crossed lines marking the centre of the bull's-eye. This is, under the circumstances, excellent work.

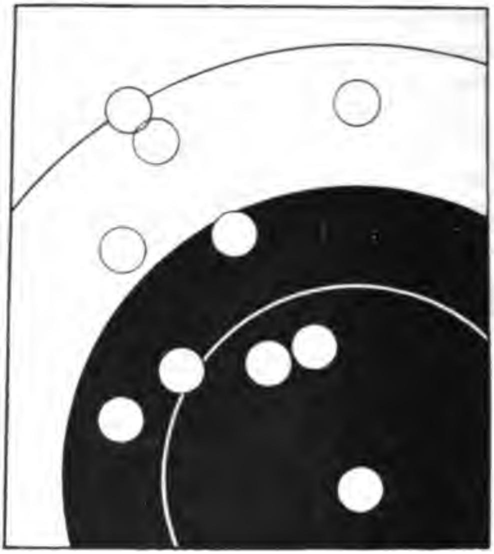


FIG. 103

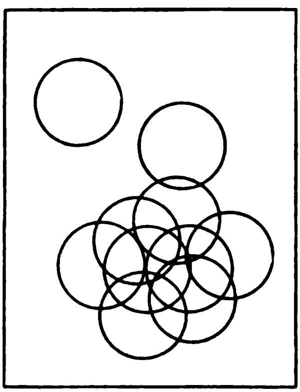


FIG. 104

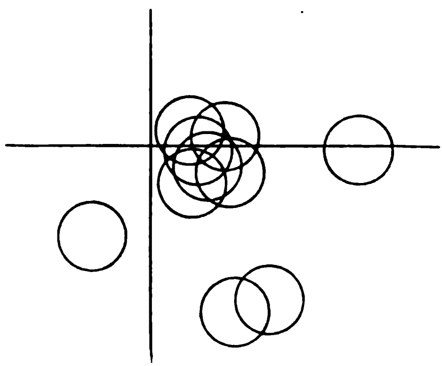


FIG. 105

The next diagram (fig. 107) represents the target made in the prone position by Sergt.-Instructor Wallingford, of the

Hythe School of Musketry, in the International Match at The Hague in June 1899. His score in 40 shots was 334 points out of a possible 400, the 10 ring measuring 10 cm., the 9 ring 20 cm., and so on.

The group is on the whole a little too high, and a little too much to the left. It measures 33 centimetres (13 inches) by 29 centimetres (11·4 inches), which at a distance of 328 yards and for so long a series as 40 shots may be considered remarkably close shooting. Wallingford, like the rest of the

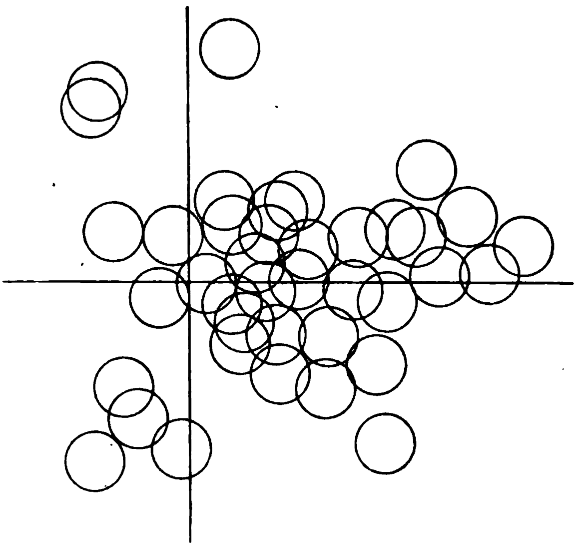


FIG. 106

British team, was using the ·303 rifle and Service ammunition, the deduction from which is that there can be little wanting in the quality of our Service arm or its cartridges, as compared with those of other nations. The care taken in the manufacture of small-arm ammunition at the Royal Laboratory at the present time would fairly astonish anyone who can remember seeing small boys putting into the cartridges the charges of black powder in happy-go-lucky fashion from flasks, in the good old days.

It is not easy to compare the shooting for the King's (*olim* the Queen's) Prize in different years, because not only has there several times been a change of rifles, but the conditions of shooting have varied, and also the size of the targets. The long-range target, however, has not varied in its dimensions since 1874, and it will be worth while to compare the best scores made with the Martini-Henry (which was first used for the Queen's Prize in 1871) and those made with the ·303 magazine rifle.

FIG. 107

In 1860 Mr. Ross won the Queen's Prize with the Whitworth rifle, with eight hits out of ten shots at 800 yards, seven at 900 yards, and six at 1,000 yards, the target being 6 feet by 10 feet, and having on it a circular centre 2 feet in diameter, which he was fortunate enough to hit with three of his shots at 1,000 yards, though he did not hit it at either 800 or 900 yards.

In 1871 Mr. A. P. Humphry, then an undergraduate at Trinity College, Cambridge, and, like Mr. Ross, destined to rise to an exceptional position as a rifleman, won the Queen's Prize with 68 points out of a possible 84, in seven shots at 800, 900, and 1,000 yards. The target was 6 feet by 12 feet, with a centre 6 feet square, and a 3 feet square bull's-eye. His range scores were, out of a possible 28 points at each distance, 24 at 800 yards, 21 at 900 yards, and 23 at 1,000 yards. The Martini-Henry rifle was used.

The highest score subsequently made with the Martini-Henry at the long ranges by a Queen's Prize winner was that of Private Beck, of the 3rd Devon, in 1881, 86 points out of a possible 105 points, in seven shots at 800, 900, and 1,000 yards. The target was as before, but the 3 feet bull's-eye was circular, and counted 5 points, and the inner was a 4 feet 6 inch circle, counting 4 points. Beck's range scores were 27 at 800 yards, 29 at 900 yards, and 30 at 1,000 yards.

In 1883 the final stage of the Queen's Prize was shot at only 800 and 900 yards, the inaccuracy of the rifle at 1,000 yards being thought to be an ample reason for discontinuing the shooting at that distance. In 1885 and subsequent years the prize has been decided no longer upon the long-range shooting alone, but upon the aggregate scores from the commencement at 200 yards. From 1886 to 1897 inclusive, sixty-six shots were fired in all, seven at 200 yards, seventeen at 500, twenty-two at 600, ten at 800, and ten at 900 yards, and the highest possible score was 330 points. The winning scores varied from 265 in 1886 to 283 in 1894, and this was the best score made with the Martini-Henry rifle. In 1897, under the same conditions, Private Ward, 1st V.B. Devon, made 304 out of 330 points, with the ·303 magazine rifle. In 1898 ten shots at 1,000 yards were added to the competition, and the highest score made so far under these conditions was again that of Private Ward, 341 out of a possible 380 points, in 1900. The effect of the changes made in 1901 in the targets and in the positions at the short ranges, and of the substitution of 800 for 500 yards in the second stage of the King's Prize, has now made comparison with the scores of past years more difficult. The score of the winner of 1901 has already been given (p. 449).

We may note the difference in scoring between the Martini-Henry and the ·303 rifle. In the eleven years from 1886 to 1896 inclusive, the scores of the Queen's Prize winners, in ten shots at 800 yards, with the Martini-Henry, averaged 40 points, and at 900 yards, 38·5. In the five years 1897 to 1901 with the ·303 rifle, the winners show at 800 yards an average of 43·2, and at 900 yards an average of 43, out of a possible 50 at each distance. Although the number of instances here taken is not large enough to establish a general rule, they indicate a superiority in the ·303 rifle over the Martini-Henry of about 7 per cent. at 800 yards, and about 12 per cent. at 900 yards. At 1,000 yards, at which the latter rifle was quite untrustworthy, the discrepancy would be much larger. The following are the most prominent names in the records of this prize: Private Cameron, 6th Inverness, won it twice, 1866 and 1869; Private Ward, 1st Devon, has done the same, in 1897 and 1900. Colour-Sergeant Lawrance, of Dumbarton, Armourer-Sergeant Parry, of Cheshire, and Sergeant Proctor, 3rd V.B. Seaforths, have all been ten times in the Sixty or the Hundred; and Private M. Caldwell, 1st V.B. Argyll and Sutherland Highlanders, Captain Foster, 4th V.B. West Surrey, Private Gilbert, H.A.C., Sergeant F. Jones, 1st V.B. Welsh Fusiliers, and Lance-Sergeant Reid, 1st Lanark, nine times each.

Perhaps the most interesting individual match recorded in the history of target-shooting in this country, arose under the following circumstances in 1870. Lieut.-Colonel Fenton tied at the Wimbledon meeting with two others for the 'Any Rifle' Association Cup, seven shots each at 200 and 600 yards, any rifle, any position. The tie was to be shot off on the last evening of the meeting, each firing seven shots. Mr. Evans and Mr. M'Vittie were beaten by Mr. E. Ross on the seven shots fired to decide the tie. Lieut.-Colonel Fenton had not fired his last shot when the evening gun, which concluded the shooting of the whole meeting, was fired, leaving the event undecided between him and Mr. Ross. They arranged to decide the tie on some future occasion convenient to both of them, but they did not succeed in meeting for the purpose until April 23 and 24, 1872, when they met by invitation of Sir Henry Halford to shoot together on his range at Wistow. It was agreed not to let the event be decided, as it commonly is in tie-shooting, by the accident of a single shot, but to fire a match at 200 and 600 yards, fifty shots at each distance, under the same conditions as before. At this time the National Rifle Association targets had 8-inch square bull's-eyes for 200 yards, and 2 feet square for 600 yards, the centres, which measured 2 feet and 4 feet, being also square, the bull's-eye scoring four points, and the centre three. On the first day, in his twenty-five shots at 200 yards, Ross, using a Metford rifle, made 94 points out of 100, and Fenton, who was using a Rigby, made 95 points. At 600 yards, the weather no doubt being unfavourable, Ross made only 82 points, and Fenton 86, out of 100, and each missed a shot. Fenton was thus left 5 points to the good, with a total of 181 against 176. On the second day the scoring was worthier of the two champions. Ross led off with twenty-three bull's-eyes at 200 yards, and his total was 99 out of 100 points, while Fenton made 95. Fenton began badly at 600 yards, and made 90 points only, but Ross, in spite of a shot wasted from firing (as it was easy to do in the days of muzzle-loading) without having loaded with a bullet, made 94, his total for the day being 193 out of a possible 200 points, and that of Fenton 185. The grand totals were therefore, Ross 369, Fenton 366, and the former won the Cup.

The 'Any Rifle' Association Cup, shot for at a later period at 600 yards only, produced an interesting tie in 1881. Major (then Lieutenant) Edge, of the 2nd Notts, and Major Young, of the 21st Middlesex, and five other competitors, among whom were Mr. Metford, Mr. Frank Hyde (the great American shot), Mr. Whitehead, and Mr. Humphry, all made the full score of ten bull's-eyes at 600 yards. They met afterwards to shoot the tie, beginning with three shots each. Young, Edge, and Humphry all made two bull's-eyes and an inner, the others doing less well. The shooting then went on shot for shot, the rule being that each round in itself might decide the event; but each competitor began with a string of six bull's-eyes. Edge and Young each added a seventh, but Humphry made an unlucky inner, and was beaten. Edge and Young went on, and each made six more bull's-eyes ; the former, who was using a Sharps rifle, made another, but Young's shot wandered into the inner. Edge was thus left the winner, having made a string of ten bull's-eyes in the original competition, then an inner, and then fifteen bull's-eyes; a remarkable performance, which those who witnessed it are not likely to forget.

In 1890 the distance for this Association Cup was changed to 900 yards, the number of shots still being ten; and the record of it shows that in every year since 1879, when the number of shots was raised from seven, that is, for twenty-two years, it has always taken a score of ten bull's-eyes, or 50 points, to win the Cup, there being usually a tie between at least two or three competitors with thirteen bull's-eyes (*i.e.* three for the first tie shots in addition to the original ten).

The 'Any Rifle' or Match Rifle Wimbledon Cup, which, with the Albert prize, may perhaps be taken to represent the highest test of individual skill with the Match rifle at Wimbledon and Bisley, has had its conditions several times varied. In old days it was a competition including more than one range, and the most prominent score in its earlier records is that of Mr. E. Ross, who won it in 1872, with a full score of seven bull's-eyes at 600 and the same at 1,000 yards. From 1880 to 1889 the conditions were fifteen shots at 1,000 yards, the highest possible score being 75 points. The scoring naturally varied with the weather in different years, but only twice in the nine years mentioned was the winning score below 68 points. In 1881 Major Godsal, and in 1886 Mr. Caldwell, each won it with 70 points, while in 1888 Mr. Henry Whitehead was the winner with 71 points, with the Metford rifle. The removal to Bisley in 1890 allowed the competition to be fired at 1,100 yards, the rifle remaining the same up to 1897. During these seven years the Cup was only won once, and that in exceptionally difficult weather, with a score of less than 65 points; in 1893 Mr. Bagshawe won it with 70 points, and in 1894 Major Gibbs with 71 points. Since 1896 only rifles of reduced calibre have been allowed, but in 1897 Mr. John Rigby, with a Mannlicher, won the Cup, still at 1,100 yards, with 71 points—a somewhat exceptionally good performance of the Mannlicher rifle. The diagram of his shooting is given in Plate LII, fig. 1. Such shooting cannot be made with these rifles except under easy conditions, and this score is not likely to be soon exceeded for the same prize.

A couple of other diagrams, illustrative of fine performances with the 'Match rifle' of later days, *i.e.* modern military rifles fitted with aperture sights, may be given. Plate LII, fig. 2, represents the last fourteen shots of the fifteen fired at 1,000 yards by Lieutenant-Colonel Mellish in the competition for the Cambridge Cup on June 27, 1900, with the Mannlicher rifle. Unfortunately, he was using an experimental bullet, which proved to require an unusual increase of elevation in going back from one range to another, and his first shot, for no sighting-shots are allowed, was a miss. But the score, of fourteen consecutive bull's-eyes, is a very fine one.

Lest it should be thought that foreign rifles alone are capable of yielding such fine results, we give (Plate LII, fig. 3) the copy of a target made at 1,000 yards with the ·303 Lee-Metford rifle by Sir Henry Halford on June 29, 1895, on his range at Wistow. This is a very compact diagram of fifteen shots, the first of which was an inner and the rest bull's-eyes, scoring 74 points. The same score-book of Sir Henry's contains two consecutive scores of 73 out of 75 points at 1,000 yards, also made with the ·303 and cannonite powder, and the writer has seen, and made, proportionately good diagrams at 1,100 yards with the ·303 rifle.

The difficulty in obtaining accurate shooting with modern military rifles and smokeless powder appears to lie much more in the production of the ammunition than in the weapon itself. The writer is entirely satisfied, after considerable experience, that the British Service rifle is capable of the very highest accuracy with suitable ammunition, and he has never yet had such good shooting from the ·256 Mannlicher as from the ·303 when at its best. The records of the scores made with the two rifles, when they have been shot by men of about equal skill, does not, on the whole, show any material difference one way or the other; but owing to the difficulty of producing ·303 ammunition which will give really first-rate results, a problem on which an immense amount of patience and time has been expended, the Mannlicher rifle, for which foreign factory-made ammunition of a very good standard can easily be obtained, is used by the bulk of long-range shots in this country.

Service ammunition in the ·303 rifle has more than once been used in the Elcho Shield match, but it is inferior in accuracy to the best ammunition of private make by a small percentage, quite enough to make a difference to the scoring. The records of the Hounslow Long Range Club, as analysed by Mr. Chadwick, the Secretary, show practically no difference between the two rifles. The highest individual score in the Elcho Shield match, 1901, was made by Mr. Ranken with a ·303 rifle and cannonite powder. He made 215 points out of 225, a score 4 points higher than that made by any other of the twenty-four men shooting. The writer has up to the current year managed to hold his own very well with the ·303 at Bisley, and has found the ·303 wear much longer than the ·256 barrel.

The regularity of the shooting with the Metford Match rifle and black powder was extremely good, and, if only for the sake of comparison, the present book would be incomplete without giving the details of the well-known fine performance of Major Gibbs, of Bristol, whose name is a household word among riflemen, on Sir Henry Halford's range at Wistow on October 11, 1886. He shot at 1,000 yards, using a Metford match rifle of ·461 bore, firing a bullet of 540 grains, and loaded with Curtis and Harvey's No. 6 powder. The rifle, as it happened, was an old one which in the hands of Major Young had often made large scores, and had had some twenty thousand shots fired out of it, an amount too small to have caused any material amount of wear and tear upon its surface, though far greater than the life of a modern small-calibre barrel fired with smokeless powder. It was a very calm day, and rather foggy, the very best condition, in fact, of atmosphere and light for high scoring. Major Gibbs fired 50 shots, all but two of which struck the ringing 3-foot bull's-eye hung upon the target. Some of the shots were not far within the bull's-eye, but the bulk of the group was very central. Of his 48 bull's-eyes no less than 37 were consecutive, being the last 37 shots fired. This shooting

PLATE LII

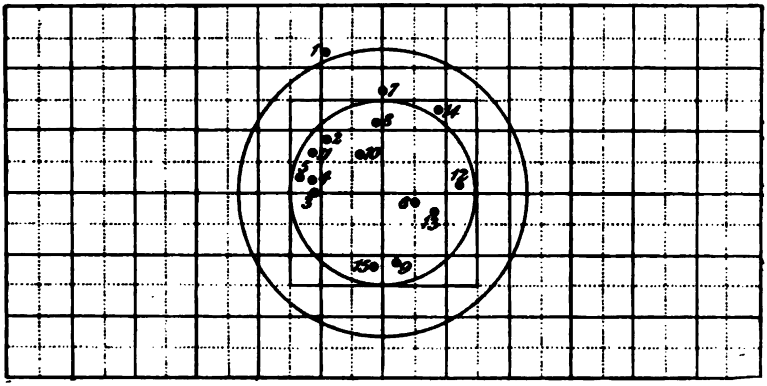


FIG. 1. FIFTEEN SHOTS AT 1,100 YARDS, JULY 16, 1897, SHOT AT BISLEY BY MR. JOHN RIGBY. SCORE : 355555455555545 = 71

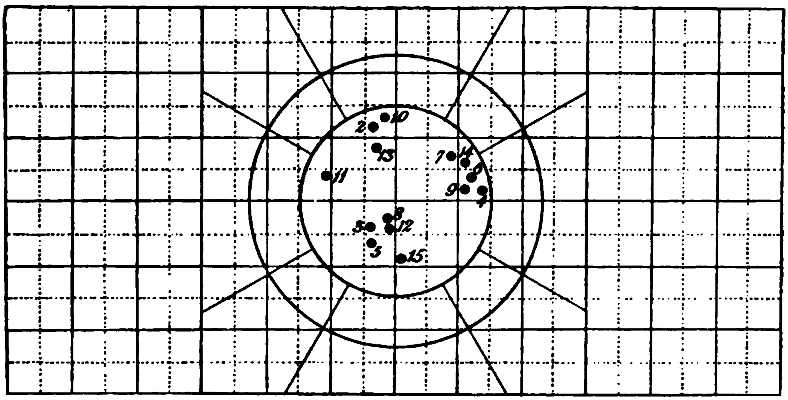


FIG. 2. FIFTEEN SHOTS AT 1,000 YARDS, JUNE 27, 1900, SHOT AT CAMBRIDGE BY LIEUTENANT-COLONEL H. MELLISH. SCORE : 055555555555555 = 70

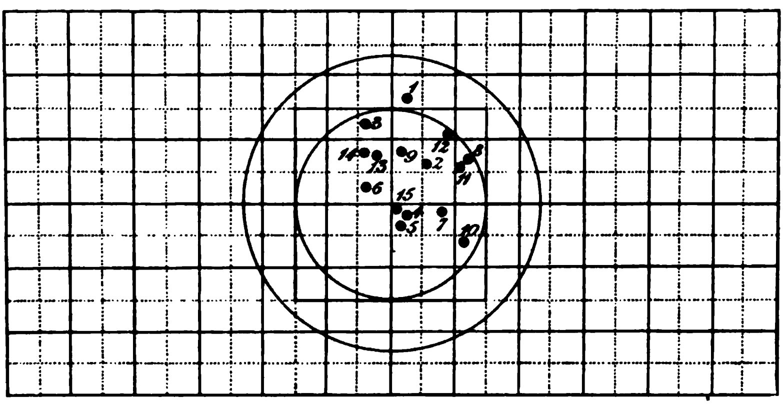


FIG. 3. FIFTEEN SHOTS AT 1,000 YARDS, JUNE 29, 1895, SHOT AT WISTOW BY SIR HENRY HALFORD. SCORE : 455555555555555 = 74

surpasses, so far as the writer knows, any shooting at 1,000 yards which has been recorded, and the string of 37 bull's-eyes at that distance is one not likely to be equalled with rifles of the modern military type. The shooter had the advantage of the assistance and advice of Sir Henry Halford, whose letter to 'The Times,' enclosing the diagram of the shooting, is appended.

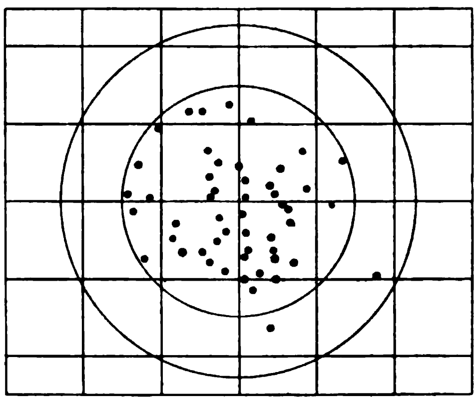
SIR,—As the question of new rifles for the army is now before the public, I think it would be interesting if you could find space to publish the inclosed diagram of shooting, made in my presence at Wistow on the 11th ult., and for the accuracy of which I can vouch. I have no pecuniary interest whatever in the Metford or any other rifle.

I am, Sir,

Yours faithfully,

H. ST. JOHN HALFORD.

11 Hobart Place, Eaton Square, S.W.
November 4.



Score :—55554555555455555555555555555f555555555555=248 points.

Fifty consecutive shots; distance, 1,000 yards; from a Metford rifle by Gibbs, of Bristol, and a ringing bull's-eye. Shot by Mr. G. C. Gibbs, and without cleaning bore. Shot on October 11, 1886, at Wistow.

Ringing bull's-eye, diameter 3 feet; shots witnessed by me and seen to be correct. H. ST. JOHN HALFORD.

Major Gibbs has for some years been almost in a class by himself as a Match rifle shot, and at the same time has performed brilliantly with the military weapon.

The scores made in team matches are not without interest in considering the standard of accuracy in rifles, and of skill in those who use them. In matches fired with the military rifle, as in individual competitions, the scoring made since the introduction of the ·303 has eclipsed that of all previous years.

The most juvenile team match at Bisley, if we except the Cadets' Challenge Trophy, is the Ashburton Challenge Shield. This has been competed for at 200 and 500 yards by teams from public schools having Volunteer Corps ever since 1861. There were eleven in each team up to 1877, but in that year the number was reduced to eight, at which it has remained ever since. In 1861 three schools—Rugby, Harrow, and Eton—competed; Marlborough joined them in 1862, and Winchester and Cheltenham in 1863. Since then the number has been largely increased, and 26 competed in 1901. Ten of the various schools have at some time or another won the shield. Harrow has won it nine times (four times consecutively, 1864-7), and had the advantage of doing so several times in the first years of the match, when the number of competing schools was very small. It is far more difficult to win it now. Charterhouse, which did not compete in the early years, has also won it nine times, beginning in the year 1882. This school won it in four consecutive years, 1889–92. Eton has won it six times at intervals; and Winchester four times, three of which were in consecutive years, 1871–3.

Lord Spencer first gave his cup, an individual prize for the champions of the different schools, in 1861, and has continued to do so ever since. The scores made for it in seven shots at 500 yards are always within a point or two of the highest possible. In the course of forty-one years representatives of no less than seventeen schools have won the cup.

The standard of shooting in the school teams is very much higher than it was twenty years ago. The success of a school depends largely upon the instruction available, as well as upon the range accommodation and the competing influence of other sports. The real importance of public school shooting lies in its after-effects, and many a man, whether or not he has subsequently joined some branch of his Majesty's forces, owes to his school or college days a taste for the rifle and an interest in it which have in some fashion proved useful to him in later life. Not a few of the prominent Bisley shots have begun their career as representatives of a public school. There is no time when the use of the rifle can be so easily taught, or when the learning of it gives so much pleasure, as in boyhood. There is a good deal to be said for the view that some instruction in the use of the rifle, perhaps on a miniature range, should be given as a matter of course to all public school boys above a certain age, whether they be Volunteers or not.

A certain number of those who have shot in the Public Schools match shoot afterwards in the matches between the Universities of Oxford and Cambridge. These are two. That for the Chancellors' Challenge Plate, given in 1862 by the Chancellors of the two Universities, is shot with the military rifle at 200, 500, and 600 yards by teams of eight. It has been won by Cambridge twenty-six times, and by Oxford only fourteen. The former University, which was successful in the first four years of the match, 1862–5, had also a series of eight victories, from 1891 to 1898. The competing claims of other occupations and amusements at the Universities, and the fact that the National Rifle Association prize meeting is held during the vacation, will account for the rather small degree of general interest shown in this contest. But there are many Volunteer officers whose interest in the force dates from their first shooting at Oxford or Cambridge.

The same causes have influenced the Inter-University Long Range Match. This is competed for by teams of four, under Elcho Shield conditions, 15 shots at 800, 900, and 1,000 yards, with Match rifles. It took place occasionally in the earlier days of the National Rifle Association, but did not appear permanently in the programme until 1880, when Mr. A. P. Humphry gave a challenge cup as a trophy for the match. Since that time Oxford has won it fourteen times (ten times consecutively, 1881–90), and Cambridge eight times. In 1901 the match was very exciting. Each team finished with a total of 790, only 5 lower than the record score of the match. This left the match a tie, and it had therefore to be decided by the range totals of the teams. At 1,000 yards Oxford had made 249 and Cambridge 248; this difference of a single point turned the scale in favour of Oxford.

Many of those whose names have afterwards figured in the Bisley records have shot in the University contests, the most prominent perhaps being Edward Ross, Karslake, and Humphry, winners of the Queen's Prize, as well as many others who have been prominently identified with the shooting and with the management of the Association, such as Earl Waldegrave, the Vice-Chairman.

The largest score on record in matches between home teams with the military rifle was that made in 1898, in the match for the National Challenge Trophy, fired under Bisley Volunteer conditions, by the Scotch team. The shooting was from the knee at 200 yards, prone at 500 yards, and in any position at 600 yards, each competitor firing seven shots at each distance, as for the first part of the Queen's Prize. The highest possible score was 105, and no less than three of the team made 102 points; one made 101, one 100, one 99, and three 98 points. The total made by the team was 1,942, or an average of 97·1 per man. This is the more remarkable, because with twenty men shooting, the average was likely to be lower than if the team had been smaller. The Scotch won this match by 26 points over the English team, who made an average of 95·8 points, which in most years would have been good enough to win the match easily. In this match the Scotch had a lead of 5 points at 200 yards, but lost it again at 500 yards, so that on going back to 600 yards, the two teams stood exactly even, and it was the magnificent shooting of the Scotch at this range that pulled off the match. One remarkable thing is the excellence of the shooting from the knee in this match. The whole of the forty competitors in the Scotch and English teams averaged 31·5 out of 35 points at the 8-inch bull's-eye at 200 yards; at 500 yards, shooting prone, they averaged 32·7 points; while at 600 yards the Scotch team averaged 32·8, and the two teams 32·2 points.

Of the 420 shots fired in this match by the Scotch team, not one missed the target, only one was an outer, 15 were magpies, and there were 125 inners and 279 bull's-eyes. There were, in fact, twice as many bull's-eyes as shots of any other denomination. The score of the winning team was as follows :

Scotland

Name	200 Yards	500 Yards	600 Yards	Total
Pillans, Sgt.	34	33	35	102
Proctor, Sgt.	33	35	34	102
Dunlop, Lieut.	35	35	32	102
McFadyen, Corp.	34	33	34	101
Rodger, Sgt.	35	32	33	100
Martin, A.-Sgt..	33	34	32	99
McHaffie, Pte.	30	33	35	98
Maccallum, Sgt.	33	31	34	98
Morrison, Sgt.	31	35	32	98
Lawrance, Sgt..	30	35	32	97
Mair, Sgt..	32	30	34	96
Reid, Sgt..	31	32	33	96
Scott, Sgt.	33	32	31	96
Muirhead, Pte..	32	28	35	95
Gray, Sgt.	30	33	32	95
Black, Sgt.	29	33	32	94
McKay, C.-Sgt..	30	33	31	94
Graham, Pte.	30	33	31	94
Yates, Lieut.	29	32	32	93
Urquhart, Pte..	29	30	33	92
	633	652	657	1,942

In the match between the teams from the Mother Country and the Colonies for the Rajah of Kolapore's Cup, the highest score hitherto recorded is that of 768 points, made by the Mother Country in 1899, an average of just 96 points, while the best record for the United Service Challenge Cup was 764, an average of 95·5, by the Army team in 1898, followed by the same team with 762 in 1899. The weather conditions require to be very favourable if such scores as these are to be equalled. The match for the National Challenge Trophy in 1898 is a proof of this, since both the English and the Welsh teams, although beaten, made on that occasion scores which surpassed all previous records. The basis of comparison in these matches has now been affected by the change of positions, and of the 200 yards target, which took place in 1900, and by the further change both of targets and of positions made by the National Rifle Association in 1901.

The chief long-range team match fired at the National Rifle Association's meeting at Bisley is that for the Elcho Shield, between teams of eight representing England, Scotland, and Ireland. A Welsh team has several times been talked of, but has never appeared. The trophy was given by Lord Wemyss in 1862, and its records form a good test of the progress of rifles, and of the developement of marksmanship at long ranges, since the conditions have been unaltered since 1874, when the 3-feet square bull's-eye was replaced by a 3-feet circular bull's-eye, and an 'inner' circle of 4 feet 6 inches was added to the target. The Elcho Shield is shot under special rules, and in this competition, sighting-shots, which are permitted in other competitions at Bisley, are not allowed. The most remarkable scoring ever made in this match was in 1892 with the old Match rifle. Curiously enough, the scores made when the shots were fired under apparently perfect conditions, that is to say, before the prohibition of cleaning out the breech-loader after every shot, were not equal to those afterwards made, in spite of the fouling caused by the black powder. In 1892 the weather was good, and the rifles and men both did their duty exceptionally well. The scores made by the Scotch, English, and Irish teams are appended. The English distinctly lost the match at 1,000 yards, having made remarkable shooting at 800 yards, at which distance no less than half their team made the full score of fifteen bull's-eyes. Their lead of 13 points from the Irish, and 15 from the Scotch, was maintained so far as the latter were concerned, at 900 yards, each team making 564 points, and at this range the Irish were 3 points behind the Scotch. At 1,000 yards the Scotch shooting was exceptional. The team averaged 71 points out of a possible 75, while the English average was only 68·6. On the total result the Scotch were 4 points ahead of the English, making 1,696 against their 1,692; and had not Ferguson most unfortunately fired his last shot at 800 yards, an inner, upon the wrong target, so that it had to be counted as a miss, the Scotch score would have been 1,700. Nevertheless the Scotch averaged exactly 212 points out of 225, and the English team 211·5, both these scores being better than any made in the match under similar conditions. All but two of those shooting used Metford rifles. The scores were as follows:

Scotland

Name	800 Yards	900 Yards	1,000 Yards	Total
Colonel Wilson, Captain				
Boyd, Pte.	73	70	74	217
Cowan, Capt.	71	70	74	215
Caldwell, Mr.	72	72	71	215
Patterson, Pte.	71	69	71	211
Thorburn, Major	72	68	71	211
Gibson, Mr.	72	71	67	210
Love, Pte.	68	72	69	209
Ferguson, Major	65	72	71	208
	564	564	568	1,696

England

Name	800 Yards	900 Yards	1,000 Yards	Total
B.-G. Sir H. Wilmot, Bart., V.C., C.B., Captain				
Lamb, Capt. T.	75	71	73	219
Gibbs, Capt.	75	73	69	217
Dutton-Hunt, Capt.	73	73	70	216
Worth, St.-Sgt.	75	68	72	215
Bulpett, Capt.	75	69	71	215
Mellish, Major	70	73	63	206
Oxley, Lieut.	73	67	65	205
Davis, Capt.	63	70	66	199
	579	564	549	1,692

Ireland

Name	800 Yards	900 Yards	1,000 Yards	Total
Duke of Abercorn, Captain				
Millner, Capt.	72	75	68	215
Fenton, Major	72	70	72	214
Braithwaite, Mr.	74	69	67	210
Cooper, Mr.	74	70	65	209
Joynt, Mr.	65	73	69	207
Wilson, Mr.	66	70	69	205
Smith, Mr.	71	67	66	204
Ganly, Mr.	72	67	62	201
	566	561	538	1,665

The next best scores in the records of the match are those of Ireland, winning in 1889 with 1,689 points, and of England in 1893 with 1,688 points. In the 1889 match, as in 1892, England made a close finish, being 5 points behind with 1,684 points. It was in 1889 that Major Lamb, shooting under Elcho Shield conditions for the officers of the Regulars against those of the Auxiliary forces, made his remarkable score of 220 points: 75 at 800, 73 at 900, and 72 at 1,000 yards. This is the largest individual score at long ranges ever made in a team match at Wimbledon or Bisley. The match of 1892 was remarkable for the largest individual score ever made in the Elcho Shield match, again that of Major Lamb, 219 points. The highest individual score ever made with the Match rifle in fifteen shots at 800, 900, and 1,000 yards, comes from across the Atlantic. Mr. William Gerrish and Major Charles Hinman are credited with 224 out of 225 points in the days of cleaning-out between shots, and the use of a very slow-burning powder.

The change in 1897 from the 'any' rifle and black powder to the Match rifle of limited bore, not exceeding ·315, has somewhat reduced the scoring, but the winning scores, although so far usually less than 1,600 points, have been higher than the worst of the scores made in the days of the Match rifle. If the time should come, as it may be hoped it will, when a proper regularity of shooting is obtained from the small-bore military rifle, the scoring should in easy weather be quite equal to what it was with the black powder rifle. In high winds and rough weather it will always be lower, because the allowances to be made for the wind are at long ranges 30 to 40 per cent. greater with the light bullet than they were with the heavy one, and consequently the effect of an error in judgment is greater by so much. The match for the Elcho Shield will not finally have served its purpose until the scoring in it again shows that the rifles and ammunition have under the new conditions been brought much nearer perfection than at present. Even then it is likely enough that further inventions or the modification of the requirements of war may give experimental shooting fresh scope for utility.

The Elcho Shield match is one in which it is a distinction to have taken part, and it is difficult to continue year after year in good enough form to deserve a place in the teams. It is remarkable that Mr. John Rigby only three times failed to shoot for Ireland in the course of thirty-three years, from 1865, when the Irish team first shot in the match, until 1897, the years that he missed being consecutive, 1890 to 1892. We believe that among the records of the match there can be found no other instance of a man who has shot for twenty-five consecutive years, though there are three marksmen who have all shot for twenty years or more for Scotland. Major Thorburn has shot twenty-three years, of which twenty-one were consecutive up to 1897; the Scotch veteran, Ferguson, twenty times, and Mr. Caldwell twenty-one times, having missed no year in the last twenty. Major Gibbs has shot for England twenty times consecutively up to the present time, and it is remarkable that he has no less than three times made 217 out of 225 in the match—in 1889, 1892, and 1894, while in 1896 he made 215. His average score in these twenty years has been 202·6, while his average for the six consecutive years, 1889 to 1894, is 212·3, in one of which years, curiously enough, he made for the only time the lowest score in the English team, 204. He has made the top score for the English team five times out of the twenty matches in which he has taken part. Sir Henry Halford shot twenty times between 1861 and 1894 in the Elcho match. In the Irish team the late Major Young, who was always prominent, made the top score five times out of twelve matches, and Major J. K. Millner has done the same six times out of his sixteen matches. In one year, 1889, he made 217 points, and in 1892 scored 215 points.

The rifle makers who devote special attention to the production of Match rifles, sights, and ammunition for this class of shooting are George Gibbs, of Bristol, John Rigby & Son, of London (formerly of Dublin), Daniel Fraser, of Edinburgh, and Alexander Martin, of Glasgow.

Great interest always attaches to international struggles in sport of every kind. The reasons which have limited the frequency of rifle matches between Great Britain and other countries are not far to seek. Canada annually sends a contingent of riflemen to compete at Bisley, and in exceptional years Australian and other teams visit us. The splendid shooting of the Victorian and the New Zealand teams in the match for the Kolapore Cup in 1897 will not soon be forgotten. But whether the match rifle or the military rifle is in question, it is difficult to meet the expense of sending a team a long distance over the sea, nor can any but a very small proportion of our prominent shots afford the time required to allow not only of previous practice, but of absence from home for several weeks or months. On the Continent rifle competitions have developed on lines so different from those which have followed in this country as not to offer much attraction to British marksmen to cross the sea, or to practise a style of shooting so different from that to which they are accustomed.

It will be worth while to mention shortly the matches in which English, Scotch, and Irish riflemen have met their American cousins. The first match, that of 1874, was fired at Creedmoor. It originated in the success in 1873 of the Irish, who had then for the first time won the Elcho Shield, and that with a very good score. The Irish Rifle Association sent a challenge for a long-range match, which was taken up by the Amateur Rifle Club of New York. The rifles, ranges, targets, and number of shots were the same as those for the Elcho Shield at that time, but the Americans were in some degree at a disadvantage, because long-range shooting had not at all been cultivated among them, and as the little book describing the match, written by Major Leech, who acted as captain of the Irish team, shows, both the rifle makers and the shots of America had at rather short notice to rival the Rigby rifle and its users. The Irish representatives included Mr. John Rigby and Mr. J. K. Millner, who are still prominent in the shooting world. The American team finishing last finally won by three points; Colonel Bodine in his last shot at 1,000 yards required to make a hit to win. He made a bull's-eye. The Irish team was unfortunate, in that Millner's first shot at 900 yards was a bull's-eye on the wrong target; this shot, had it not been wasted, would have turned the scale in favour of the visitors. The scores were as follows:

America

Name	800 Yards	900 Yards	1,000 Yards	Total
Henry Fulton	58	57	56	171
G. W. Yale	55	56	51	162
Col. Bodine	54	51	53	158
L. L. Hepburn . . .	53	50	46	149
Col. Gildersleeve . .	53	51	51	155
General Dakin . . .	53	45	41	139
	326	310	298	934

Ireland

Name	800 Yards	900 Yards	1,000 Yards	Total
John Rigby	52	56	55	163
Dr. J. B. Hamilton . .	58	52	50	160
James Wilson	54	51	55	160
J. K. Millner	57	49	48	154
Edmund Johnson . . .	50	49	51	150
Capt. Walker	46	55	43	144
	317	312	302	931

One or two smaller events were decided on this same occasion. In a subsequent competition for the Bennett long-range championship, an individual match under the same conditions as the team match, the six highest Irish scorers were a long way ahead of their American competitors in the match.

A challenge by Mr. Rigby for a match between muzzle-loading rifles of his own make and American breech-loading rifles, for competitors firing twenty-five rounds each without cleaning, ended in a very easy win for the muzzle-loaders, for great as was the reputation which the Sharps breech-loader obtained for itself a few years later, it was at this time quite unfitted to make fine scoring when not cleaned between the shots. The lowest score made by the Rigby rifle was higher than the highest made by the Sharps rifle. The scores were as follows:

Rigby Rifles, Muzzle-loaders — *Irish Team*		Sharps Rifles, Breech-loaders — *American Team*	
E. Johnson	84	J. Collins	75
J. Rigby	84	General Dakin	64
J. B. Hamilton	77	H. Gildersleeve	49
J. Wilson	76	G. Yale	13
	321		201

A curious little match was fired, too, between Mr. John Rigby and General Dakin, five shots each standing, at 1,000 yards. The result was as follows:

Rigby, 40340 = 11 Dakin, 03400 = 7.

The value of a bull's-eye at that time was four points. The writer knows of no other instance when, in public, at all events, a match has been shot standing at so long a distance.

In 1875 a return team match was shot at Dublin, in which the American riflemen were again successful. This match was shot upon the well-known Dollymount range, which is practically on a sandbank in Dublin Bay. The Americans used Remington rifles. The weather was overcast, but not difficult for shooting, and the visitors won the match very easily with what was then the very wonderful score of 967 points out of a possible 1,080. The scoring was as follows:

America

Name	800 Yards	900 Yards	1,000 Yards	Total
Col. Gildersleeve . . .	56	56	52	164
Mr. Yale	57	52	51	160
Major Fulton . . .	58	57	46	161
Mr. Coleman . . .	56	48	52	156
Col. Bodine . . .	52	59	51	162
Gen. Dakin . . .	58	55	51	164
	337	327	303	967

Ireland

Name	800 Yards	900 Yards	1,000 Yards	Total
Mr. Wilson . . .	58	50	55	163
Dr. Hamilton . . .	56	54	50	160
Mr. McKenna . . .	52	44	53	149
Mr. Millner . . .	55	37	41	133
Mr. Johnson . . .	58	54	51	163
Mr. Pollock . . .	59	53	49	161
	338	292	299	929

The American riflemen afterwards attended the Wimbledon meeting, but declined an invitation to shoot a match there against a team from the United Kingdom. A challenge cup was given by the National Rifle Association for competition among the Americans at Wimbledon, the conditions being thirty shots at 1,000 yards, and Major Fulton won it with 133 points out of 150, with the Remington rifle.

In 1875 the National Rifle Association had been invited to send a British team to contend in America against an American team in a great International Match to be organised in connection with the Centennial Celebration. In the autumn of that year the Council of the National Rifle Association decided to accept the invitation, and Sir Henry Halford was appointed to be the captain of the team. It had been arranged to hold competitions among those available, and to take the best team that could be made up from the pick of the English, Scotch, and Irish shots. In December, 1875, however, when the formal challenge arrived, it was found to have been sent, not only to the National Rifle Association, but to the Irish Rifle Association and the Scottish National Rifle Club. The Council were not prepared to send an English team, as they considered themselves to represent the whole United Kingdom, The Scotch Association determined to send a Scotch team, and the National Rifle Association withdrew their acceptance of the challenge. The Irish, too, got together a team, and so did the Canadians and Australians. The conditions were as for the Elcho Shield, but repeated on two consecutive days, the new Wimbledon scoring being adopted, which increased the number of points made. The Americans again proved themselves the better men, although their win was not at all an easy one. The Irish team were second, 22 points behind, having had a lead on the first day and lost it on the second. The Scotch also made a larger score than the Americans on the first day. The highest score made up to that time in the Elcho Shield match at Wimbledon was 1,506, a score very easily beaten on both days by the American, Irish, and Australian teams, and on the first day by the Scotch. The conditions of light and weather in this country, as is well known to those who have shot in India or in South Africa, are less favourable to high scoring. The following were the scores:

American Team

—	800 Yards	900 Yards	1,000 Yards	Total
First day	550	518	509	1,577
Second day . . .	525	515	509	1,549
	1,075	1,033	1,018	3,126

Irish Team

—	800 Yards	900 Yards	1,000 Yards	Total
First day	535	524	523	1,582
Second day . . .	502	485	535	1,522
	1,037	1,009	1,058	3,104

Australian Team

—	800 Yards	900 Yards	1,000 Yards	Total
First day	531	524	490	1,545
Second day . . .	522	494	535	1,551
	1,053	1,018	1,025	3,096

Scotch Team

—	800 Yards	900 Yards	1,000 Yards	Total
First day	535	528	523	1,586
Second day . . .	525	462	488	1,475
	1,060	990	1,011	3,061

Canadian Team

—	800 Yards	900 Yards	1,000 Yards	Total
First day	521	476	493	1,490
Second day . . .	492	465	476	1,433
	1,013	941	969	2,923

In the spring of 1877 a renewed invitation was received for a British team to be sent to compete for the American Centennial Trophy, and the championship of the world, under the same conditions as had been proposed in the previous year, the match to be shot in the following September. It was decided to accept the invitation, if neither Scotland nor Ireland intended to send teams. Sir Henry Halford acted as organiser and captain of the British team, and after the Wimbledon meeting held a three days' competition at Cambridge among the long-range shots willing to go to America. The ten who took the highest places were Humphry, Colonel Fenton, Evans, Piggott, Halford, and Gilder, Englishmen; Ferguson and Dunlop, Scotchmen; Rigby and Young, Irishmen; and they were declared to form the team and reserve. At the last moment, however, Major Young and Mr. Dunlop were prevented from leaving England, and were replaced by Lieutenant Fenton and Mr. Millner, who had shot in the Irish team against the Americans in 1876. The match at Creedmoor again lasted two days, the Elcho Shield course of fifteen shots at 800, 900, and 1,000 yards being fired on each day. The teams were eight a side. Both Lieutenant Fenton and Mr. Millner shot, Gilder and Piggott having been placed in the reserve. It was almost as much a match between the rifles of the two nations as between their representatives. The Americans, who used Sharps and Remington's rifles, were 26 points ahead on the first day, and on the second day added as much as 66 points to their lead. By dividing the target into a large number of very small divisions, each of which was distinguished by a particular word, the place hit by each shot fired could at once be cabled across the Atlantic. The scores are given on the next page.

Colonel Peel, who accompanied the team, wrote a report upon this match, in which he attributed the American success to their vastly superior team organisation, to the use by some of the English shots of the prone position, while all the Americans shot upon the back, and to the use by the Americans of a breech-loader, which they cleaned out after every shot, instead of a muzzle-loader. This report, which is reprinted in the National Rifle Association's Report for 1877, contains valuable remarks upon the organisation of

American Team

Name	First Day				Second Day				
	800 Yards	900 Yards	1,000 Yards	Total	800 Yards	900 Yards	1,000 Yards	Total	Grand Total
Blydenburgh, C. E.	74	67	72	213	73	72	71	216	429
Bruce, L. C.	70	73	63	206	74	72	73	219	425
Weber, L.	69	73	64	206	74	71	70	215	421
Allen, J. L.	71	66	69	206	70	73	70	218	419
Jewell, H. S.	71	66	72	209	72	65	73	210	419
Hyde, F.	71	70	68	209	72	68	65	205	414
Jackson, W. H.	69	69	66	204	70	66	67	203	407
Dakin, T. S.	73	63	66	202	70	67	61	198	400
	568	547	540	1,655	575	554	550	1,679	3,384

British Team

Name	First Day				Second Day				
	800 Yards	900 Yards	1,000 Yards	Total	800 Yards	900 Yards	1,000 Yards	Total	Grand Total
Halford, Sir Hy.	71	63	71	205	72	69	66	207	412
Evans, H. S. W.	71	70	66	207	72	67	66	205	412
Rigby, Wm.	73	65	69	207	72	69	62	203	410
Fenton, Lieut. G.	65	70	69	204	69	64	70	203	407
Millner, J. K.	72	70	67	209	70	66	62	198	407
Ferguson, W.	72	67	67	206	70	67	63	200	406
Fenton, Lieut.-Col. J.	71	62	65	198	70	66	66	202	400
Humphry, A. P.	63	70	60	193	64	68	63	195	388
	558	537	584	1,629	559	536	518	1,613	3,242

teams, as well as upon the comparative merits of the rifles and other questions raised by the match.

In 1878 a team was again invited to visit Creedmoor, but the Association could not send one, the time involved and the expense of the journey being the chief obstacles. Similarly, in 1879, the Association did not see its way to accept a like invitation and to send a team to America to compete with the military rifle.

In 1880 Mr. F. Hyde brought a team to Wimbledon. The Association of the United States would not officially sanction a match between the American team and a team representing the National Rifle Association, so that the match was unofficial as between Mr. Hyde's team and Sir Henry Halford's. The conditions of the match were similar to those for the Elcho Shield, and it was won by the British team with 1,647 points against 1,568. The scores were as follows :

Sir Henry Halford's Team

Name	800 Yards	900 Yards	1,000 Yards	Total
Millner	74	71	67	212
Fenton	73	71	65	209
Humphry	73	70	64	207
Young	70	67	69	206
Baker	73	71	61	205
Joynt	71	72	61	204
Evans	74	69	59	202
Godsal	72	68	62	202
	580	559	508	1,647

Mr. Hyde's Team

Name	800 Yards	900 Yards	1,000 Yards	Total
Jackson	72	69	68	209
Laird	67	71	67	205
Scott	73	67	63	203
Brown	71	71	60	202
Hyde	69	63	66	198
Dudley	66	64	67	197
Gerrish	72	60	58	190
Rockwell	54	50	60	164
	544	515	509	1,568

The Americans had thus won one and lost one match (the latter, however, an unofficial one) with the 'Any Rifle' against teams representing the United Kingdom.

In November, 1880, a challenge was sent to the National Rifle Association of America to shoot a match in the following year, but it was refused. Early in 1881 the American Association sent a challenge, and it was practically arranged that a match should take place the next season, but upon conditions as to distances and rifles different from those of previous contests. Consequently in 1882 a team of Volunteers went to America to compete both at short and at long ranges against a team of the National Guard of the United States. Sir Henry Halford was captain of the British team, and took over with him a party of picked marksmen armed with the military breech-loader, which had for some years been so familiar a weapon at Wimbledon. The match was to last two days, the shooting on the first day being at 200, 500, and 600 yards, and on the second day at 800, 900, and 1,000 yards, seven shots at each distance. Twelve men fired in each team. The shooting at 200 yards was in the standing position, in which it was generally thought that the American team would have the advantage, since off-hand shooting was normally practised at that distance in America, but not in this country; while, on the other hand, it was thought that the long ranges might tell on the whole in favour of the British team.

The match proved an unexpected success for the British team, who beat the American team at 200 yards in the standing position by 9 points, gained 9 more points at 500 yards, and 1 more at 600 yards, the two latter ranges being shot in the prone position. The second day increased their lead enormously. The long ranges were shot in any position, and at 800 yards they gained 38 points, at 900 yards 42 points, at 1,000 yards 71 points. They were thus winners by 170 points. Ten out of the twelve in the British team shot with the Metford rifle, and Bates and Godsal with the Webley-Wyley, a rifle which shot well, but had the disadvantage of needing heavily lubricated ammunition. Of the American team, nine used the Remington, two the Sharps, and one the Hotchkiss rifle. The Americans naturally supposed that the British had produced a long-range rifle specially for this match, but nothing of the sort had been done, for none of the rifles used in the match had been made specially for it, and some had been in use for five or six years in competitions at Wimbledon. They also supposed that the users of the rifles were expert long-range Match rifle shots, but in fact the majority of the team were essentially military shots, and not experienced with the Match rifle. The scores in the match were as follows:

British Team

Name	First Day				Second Day				Grand Total
	200 Yards	500 Yards	600 Yards	Total	800 Yards	900 Yards	1,000 Yards	Total	
Pearse	28	32	29	89	29	32	27	88	177
McVittie	31	34	30	95	26	30	25	81	176
Parry	28	33	29	90	25	24	31	80	170
Boulter	26	32	32	90	31	25	24	80	170
Caldwell	26	33	31	90	25	26	25	76	166
Dods	31	31	32	94	26	26	20	72	166
Oliver	27	30	29	86	21	31	27	79	165
Bates	28	31	28	87	24	28	25	77	164
Godsal	29	27	30	86	29	24	22	75	161
Humphry	27	32	24	83	21	23	32	76	159
Goodear	28	29	24	81	26	26	25	77	158
Heap	31	34	26	91	10	18	24	52	143
	340	378	344	1,062	293	313	307	913	1,975

American Team

Name	First Day				Second Day				Grand Total
	200 Yards	500 Yards	600 Yards	Total	800 Yards	900 Yards	1,000 Yards	Total	
Smith	30	34	31	95	26	26	21	73	168
Pollard	29	31	33	93	23	28	18	69	162
Hinman	30	32	28	90	19	26	23	68	158
Atkinson	29	32	27	88	26	23	19	68	156
Ogden	27	31	31	89	27	17	20	64	153
Dolan	25	28	34	87	16	27	21	64	151
McNevin	22	33	30	85	17	23	23	63	148
Howard	25	29	29	83	19	16	29	64	147
Shakspeare	31	29	25	85	16	24	21	61	146
Paulding	27	31	24	82	20	20	20	60	142
Alder	27	30	23	80	27	22	11	60	140
Hinds	29	29	28	86	19	19	10	48	134
	331	369	343	1,043	255	271	236	762	1,805

In the following year, 1883, a return match was shot at Wimbledon under the same conditions, between teams of twelve. The organisation of the British team on that occasion was only taken in hand at the last moment and left much to be desired. At 200 yards the American team obtained a lead of 12 points; at 500 yards the British recovered 10 points, but at 600 yards lost 6 points, and so were 8 points to the bad on the first day. On the second day, at the long ranges, the weather was difficult. The Americans did well at 800 yards, and gained 16 points more. This rather formidable lead of 24 points was more than wiped off at the 900 yards range, where the British score was 297, as against the American 263, and at the 1,000 yards the British increased their lead by 35 points more, winning the match by 45 points. Whatever the respective capacities of the marksmen may have been, it is quite clear that in this match, as in the first, the rifles of the British were better than those of their opponents, although eight of the latter used a new rifle, the Brown rifle, and the remainder Remingtons, while eleven of the British used the Metford as before. It is probable, too, that the difficult winds of Wimbledon placed the visitors at a disadvantage. The winning score in this match was rather lower than that of the previous year, but the American team improved by 101 points on their previous performance. The scoring was as follows:

British Team

Name	First Day				Second Day				Grand Total
	200 Yards	500 Yards	600 Yards	Total	800 Yards	900 Yards	1,000 Yards	Total	
Wattleworth	32	32	30	94	32	27	27	86	180
Gibbs	25	33	34	92	27	29	28	84	176
Parry	28	32	29	89	26	26	29	81	170
Bates	29	34	30	93	29	28	20	77	170
Gouldsmith	31	31	27	89	31	27	22	80	169
McVittie	29	31	29	89	24	30	20	74	163
Godsal	27	32	32	91	28	28	16	72	163
Pearse	27	33	29	89	22	26	21	69	158
Dods	28	23	30	81	32	21	21	74	155
Lowe	28	35	26	89	24	22	16	62	151
Humphry	26	29	30	85	27	13	24	64	149
Young	30	31	28	89	28	20	10	58	147
	340	376	354	1,070	330	297	254	881	1,951

American Team

Name	First Day				Second Day				Grand Total
	200 Yards	500 Yards	600 Yards	Total	800 Yards	900 Yards	1,000 Yards	Total	
Scott, Pte.	29	30	31	90	33	28	22	83	173
Hinman	29	35	32	96	27	26	19	72	168
Van Heusen	29	32	29	90	30	24	20	74	164
Scott, Lieut.	29	27	32	88	32	20	22	74	162
Paulding	31	29	30	90	31	23	17	71	161
Brown	30	29	31	90	25	19	27	71	161
Dolan	31	30	23	84	28	26	19	73	157
Bull	28	30	32	90	32	20	15	67	157
Joiner	29	33	34	96	28	20	10	58	154
Pollard	30	31	26	87	29	18	19	66	153
Smith	29	34	32	95	27	17	10	54	149
Cash	28	26	28	82	24	22	19	65	147
	352	366	360	1,078	346	263	219	828	1,906

In 1886 a challenge was sent by the Americans for a match in the autumn, but was regretfully declined. After that time target-shooting, and especially Match-rifle shooting at long ranges, nearly died out in the United States, but military shooting shows signs of revival there since the Spanish war. A team of the Ulster Rifle Association crossed the Atlantic to shoot against the New Jersey Rifle Association with the Match rifle at Seagirt in the present autumn of 1901. They won the match, which was under Elcho Shield conditions, with a score of 1,620 points, the home team making only 1,558 points. The Ulster team used the Mannlicher, and the Americans a Remington rifle. Major Richardson made the fine score of 217 points for Ulster. At the same meeting the match for the Palma Centennial Trophy, to which Great Britain was unable to send a team, was won by Canada. Each team used the military rifle of its country, with orthoptic sights attached. It is to be hoped that other friendly matches between this country and other nations may be arranged in coming years. Shooting at distances beyond 600 yards is a distinctive feature of the sport among English-speaking nations. The military importance of long-range practice has increased, and it should be included in any such matches, whether with the military rifle or the Match rifle.

Some few years ago there was established on the Continent an International Rifle match in which several of the chief

Continental countries annually take part. In 1899 this match was held in connection with a prize meeting in Holland, at Loosduinen, near The Hague, and a scratch British team went over, much doubt being felt as to whether Continental methods were sufficiently like our own to give the team any chance of success. These doubts proved to be well founded. The match was fired exclusively at 300 metres (328 yards). The targets were 1·80 metre (5 feet 11 inches) square, but no shot counted which was outside a circle of 1 metre (3 feet 3·4 inches) in diameter. This was subdivided into smaller circles, each 10 centimetres (3·9 inches) smaller than the last, a hit in the innermost circle of 10 centimetres counting 10 points, one in the next of 20 centimetres counting 9, and so on. The inner rings were blackened so as to give a bull's-eye of aim of 60 centimetres (23·6 inches). The teams consisted of five members, and each man had to fire 40 shots standing, 40 kneeling, and 40 prone during the day. Sighting shots were allowed. The British team all fired with the ·303 Service rifle and with Service ammunition. The result, so far as concerns the place taken by them in the match, was decidedly a failure. There were eight competing nations, and the scores made were as follows:

Name of Country	Standing	Kneeling	Prone	Grand Total
Switzerland . . .	1,426	1,559·875	1,543	4,528·875*
France	1,403	1,449	1,552·175	4,404·175
Denmark . . .	1,367·90	1,490	1,533	4,390·90
Italy	1,281	1,455·45	1,577·45	4,313·90
Holland	1,316·650	1,442·350	1,518	4,277
Norway	1,384·075	1,365·125	1,395·450	4,144·650
Great Britain . . .	1,138·70	1,449·65	1.541	4,129·35
Belgium	1,292·700	1,360·65	1,474·525	4,127·875

* The decimal points are due to a peculiar system of penalising misses.

It will be seen that in shooting standing the British team made much the lowest score, while in kneeling and prone shooting it held its own very much better. The best score in the British team was made by Sergeant - Instructor Wallingford, of the Hythe staff, who, as has been mentioned, took the prize given for the highest individual score in the prone position, but his total in the three positions was not equal to the average score made by the winning team. It is clear from his performance that the rifles and ammunition were quite as accurate as those used by the other teams, and there is not the smallest reason to suppose that the skill of the men was inferior. Their chances of winning were much more heavily handicapped than had been anticipated by the difference of the conditions of Continental shooting from those of shooting as practised here. The scores of the British team were as under:

Name	Standing	Kneeling	Prone	Grand Total
Sgt.-Inst. Wallingford, Hythe Staff	261·30	308	334	903·30
Major Cowan, Royal Engineers	242·35	292	325	859·35
Staff-Sgt. Rothon, 12th Middx. R. V.	224·25	286·65	307	817·90
Qr.-Mr.-Sgt. Davidson, Hythe Staff	238	272	273	783
Cr.-Sgt. Davies, 1st V.B. Welsh Rgt.	172·80	291	302	765·80
	1,138·70	1,449·65	1,541	4,129·35

We have already given a reproduction of Sgt.-Inst. Wallingford's target of 40 shots, prone, made in this match.

The following extract from the Report presented to the Council of the National Rifle Association in connection with the Match will show both the actual points which adversely affected the British team, and the general difference of the system on which rifle-shooting has been developed in this country and abroad:

'Some opportunity had been given to the team to fire at home at a bull's-eye of the same kind as that used in the match—24 inches at 328 yards—the equivalent of a 36-inch bull's-eye at 500 yards. This naturally requires rather a different method of aiming from that suited to Bisley targets. But the additional difficulty of shooting from under a low roof in a stall partitioned on both sides is considerable. The use of the "bar" sight is almost precluded, as no light falls on the sights from above or behind, and they have to be defined against the glare of a patch of sky seen over the targets. This made to our men a much greater difficulty than had been anticipated.

'Many of the other teams used for the standing position at least—most of them for all positions—fancy rifles of great weight, with "set" or "hair" triggers, which give, as compared with a heavier pull-off, a great advantage in standing and some in kneeling. These rifles were in many cases fitted with elaborate unpractical devices to assist the grasp of the rifle. When military rifles were used the pull-off had been specially arranged so as to require a pressure of 2 lbs. or less; the pull-off of the Lee-Metford, though reduction was effected so far as possible by extemporised means, could not be brought below 4 lbs.

'The great number of shots fired in the match, 30 sighters and 120 shots in competition per man, proved unexpectedly fatiguing, and much increased the disadvantages due to heavy pull of trigger, &c. Few of our men can give the requisite time or obtain sufficient accommodation on their ranges to accustom themselves to fire so many shots in the day with due care and deliberation.

'The only distance fired at in all the rifle competitions of the Dutch meeting was 300 metres (about 328 yards), and it appeared that one at least of the teams had not had occasion to fire all the season except at the particular distance and target used in the match.

'It must, however, be admitted, after making all these allowances, that the standing shooting of our team was not up to the foreign standard. Far more attention is given to the cultivation of the standing position abroad, while our system of shooting imposes upon no one the strain of firing a long series of shots standing in any important competition.

'The International Match, as at present arranged, must be considered unsatisfactory as not conforming to practical or military requirements. Thus, the innermost circle of the bull's-eye (4 inches in diameter) and the width of the 2-inch rings into which it and the rest of the target are divided, are so minute as to be beyond the accuracy of the rifle at 300 metres. In the kneeling position cushions and supports for leg and foot are allowed, and your delegates were only able to get the position so far restricted as that both knee and foot should touch the ground. The couches provided for lying down were narrow and placed at a steep slope to suit the crooked stocks generally used, and special permission had to be asked for the British team to shoot off the bare ground. While aperture sights were forbidden, open sights of all patterns, often with very delicate screws for adjustment, were used. The customs of shooting from under cover and at one distance only are such as would never be adopted in this country. To sum up, rifle competitions seem to be looked upon, except by Great Britain, Norway, and Denmark, as a fancy sport, which is not meant to bear any particular relation to military or useful conditions.'

The above sufficiently shows that the chief part of the British team's failure in the match was due to the practical and military lines on which rifle-shooting has been developed in this country. It does not seem that for the sake of again competing in this match it will be worth while in any future year specially to arm and train a team under conditions which would almost certainly put them quite out of their form for shooting in our home competitions, and it is probable that until the International match is put upon lines more compatible with the use of military weapons, it will evoke no special interest in Great Britain and Ireland.

CHAPTER XX

ANCIENT RIFLE CLUBS—SOME SWISS CLUBS—THE VICTORIA RIFLES—RIFLE CLUBS AND VOLUNTEERING—THE GUN LICENCE—COST OF AMMUNITION—DIFFERENT TYPES OF CLUBS—SUNDAY SHOOTING—ORGANISATION OF CLUBS—COMPETITIONS AND MATCHES—CONDITIONS OF AFFILIATION TO NATIONAL RIFLE ASSOCIATION—LIST OF RIFLE CLUBS

It would be difficult to assign a date to the beginning of target competitions with small arms. Both the long-bow and the cross-bow were very naturally used both by societies and by gatherings of parishes or localities, at which the most successful shot gained the greatest honour. We find that in Switzerland such societies existed before the invention of fire-arms, and carried on their competitions and practice continuously, as it would seem, through the change in weapons, first from the bow to the gun, and then from the gun to the rifle. The Honourable Artillery Company of London, the direct descendant of the old trained bands, has seen the same series of changes, and affords the nearest parallel which we have in this country to the ancient clubs of the Continent. The Société de l'Harquebuse of Geneva, which represents the practising of the citizens under municipal patronage, and has existed for more than 500 years, can show that as early as 1474 both the archers and those who shot with the arquebus held competitions which were assisted by prizes given by the Petit Conseil de Genève. The records of the Council show that before 1460, and no doubt much earlier, there had been a champion both of the long-bow and of the cross-bow, but no mention of arquebus shooting appears until 1474. An improved range for shooting with both cross-bow and arquebus at Geneva was apparently made at the beginning of 1475, and this may perhaps be taken to represent the period at which the hand gun began to be considered an arm of some precision. But there remains little, if any, record of the details of the competitions held at these early periods, either as to the distance at which the firing took place, or as to the conditions of the target, &c., governing the competitions. In those held by the Genevan Club for the cross-bow and the fire-arm there was a championship at this time, the most successful shot being known for the year as the King of the Cross-bow or Arquebus. It seems very likely that his position depended upon his good fortune in striking the target most nearly in the centre, as that has been, and still to a great extent is, in Switzerland the chief measure of a man's success as a shot. There seems to have been a continuous succession of Kings of the Arquebus and Rifle from 1474 down to the present time, but unfortunately the records do not show clearly the transition from the smooth-bore arquebus to the grooved rifle.

A similar, and perhaps even older, society still exists at Zürich, and in the Swiss National Museum at that place may be seen a very beautiful cup made in the shape of a rifleman with his arquebus, which has belonged to the club since 1646. We are able, through the kindness of Mr. Angst and of Dr. W. H. Doer, to give a photograph of this cup (Plate LIII), and of an even more curious old Swiss picture on stained glass showing a man shooting at a target (Plate LIV). The marker has a disc with which to signal the shot, and wears, as Swiss markers do to this day, a red coat. He has a substantial shelter to protect him, and apparently comes out from it to mark the shots. The date of this picture is about 1525, so that it marks a time earlier than that at which the rifle was in vogue, and almost certainly represents shooting with the smooth-bore arquebus. Mr. Schmidt, in his excellent volume on Small Arms, quotes the following edict as having been issued by the Swiss Government at Berne in the year 1563; it would seem to mark clearly the time at which rifled barrels began to be appreciated and come into use:

'For the last few years the art of cutting grooves in the chamber of the guns has been introduced with the object of increasing the accuracy of fire; the disadvantage resulting therefrom to the common marksmen has sown discord

PLATE LIII

DRINKING CUP. RIFLEMAN OF THE ZÜRICH SHOOTING CLUB, 1646

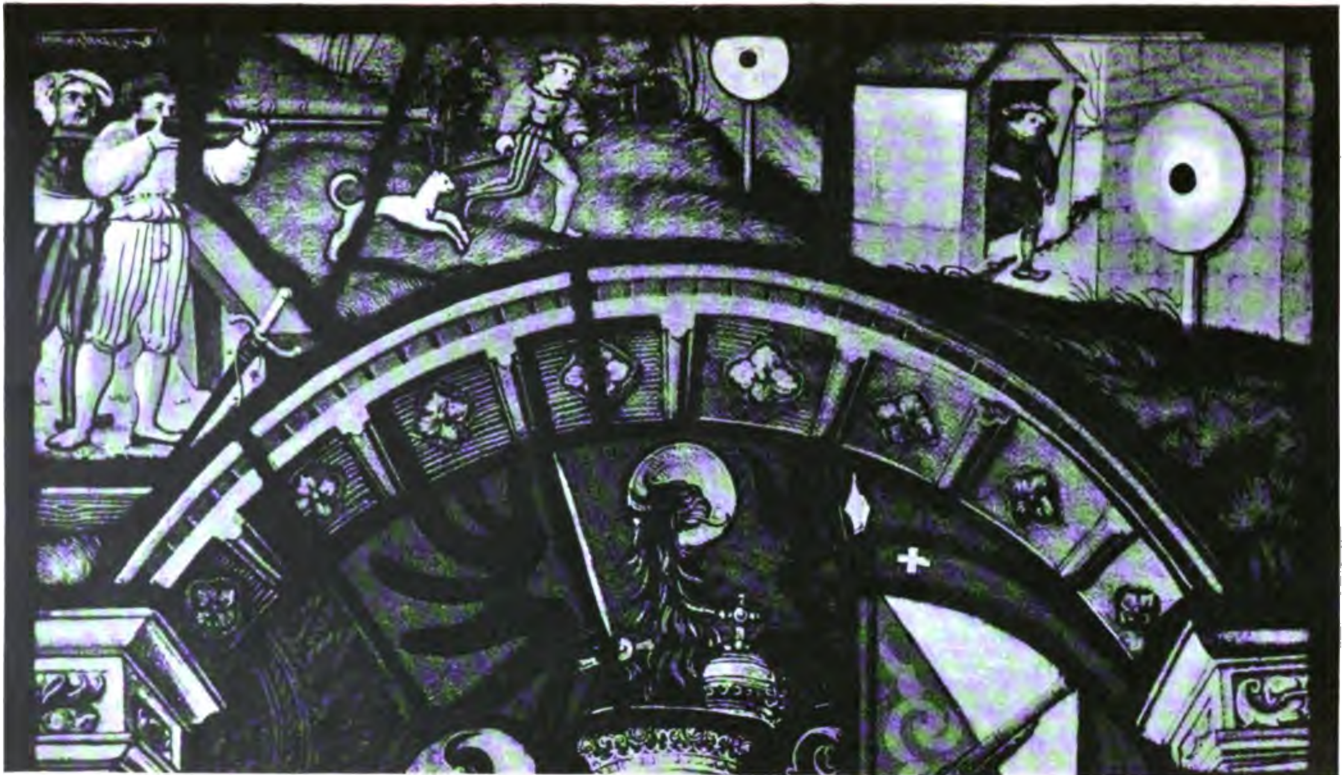
amongst them. In ordinary shooting matches marksmen are therefore forbidden under a penalty of 10*l.* to provide themselves with rifled arms. Everyone is nevertheless permitted to rifle his military weapon and to compete with marksmen armed with similar weapons for special prizes.'

The Swiss Rifle Clubs have now become a part of the military organisation of the country, and their machinery is used for the compulsory practice of those liable to be called up for active service.

Although Rifle Clubs are, as has been shown, an institution on the Continent as old as the rifle itself, we do not hear anything of competitive rifle shooting or the formation of clubs in this country until about a hundred years ago, and in fact in this country the clubs date only from the time when the rifle became a recognised military arm. They were naturally formed in connection with the Volunteer movement of the end of the eighteenth century, and the Victoria Rifles (now incorporated with the St. George's Rifles, the 1st Middlesex) have the distinction of having maintained their existence as a rifle club right through the interval between the first Volunteer movement, in which they existed as the Duke of Cumberland's Sharpshooters, and the second Volunteer movement of 1859–60. From 1815 to 1850 the number of rifle clubs existing was very small, and rifle-shooting was pursued rather as a pastime than as a military exercise. We hear of occasional matches, but they were at short distances, as when Lord Vernon and Lord Kennedy shot a match at 100 yards for 20*l.* a side at the Red House, as related by Captain Ross. Lord Vernon was firing practice shots before Lord Kennedy's arrival. He was shooting badly, being evidently nervous, and Captain Ross offered to shoot five shots with a pistol at 100 yards against his rifle, and beat him. Lord Vernon was familiar with Swiss rifle shooting for more than ten years before the foundation of the National Rifle Association, and his experience was valuable to it. He had tried many modifications of the Swiss sights, and had devised the aperture foresight by 1850.

From about that time there was a movement to revive rifle clubs as a defence against invasion, but with the new

Volunteer movement there arose great questioning as to the desirability of establishing more rifle clubs, and as to how far they should supplement or exist in substitution for Volunteer corps. This is well brought out by the veteran special correspondent of the 'Times,' Sir W. H. Russell, in a little book, published in 1859, dealing with all the phases of voluntary national defence at that time. It would seem that in 1859 the general opinion was that on the whole more organisation and discipline was advisable than is consistent with mere club organisation. Sir William Russell, commenting on the tendency at the moment at which he was writing to favour clubs or associations of riflemen, instead of corps or companies, says: 'This tendency is unfavourable to real efficiency, and to utility in case of need. I say it without offence, but in all truthfulness, that I would not place much reliance on rifle "clubs" in event of an invasion, and that I fear they would be nearly useless for military purposes.' 'What I contend for,' he says, 'is the "Rifle Company" regularly officered and regularly drilled, and well practised, which in time can act in concert with its fellows in a battle, and which may be regarded as a military body.' It is quite true that men who are skilful shots can individually do a certain amount of good work, but when the problem is to oppose organised masses of well-armed and well-drilled troops, organisation and cohesion, as well as the habit of co-operation in manœuvring and firing, are indispensable. These are what the mob of armed men, so roughly handled by military critics in the Press in these days, lack, and always must lack. Not only must a body of men for military purposes be under organisation sufficient to meet the difficulties of commissariat and ammunition supply, but it must have a feeling of unity for a common purpose, of unhesitating subordination to its leaders, and of interdependence among individuals upon mutual support, which absolutely demand training of a special kind. If it be thought, however, that on this account there is no use in rifle clubs, it must be pointed out that a rifle club may be a very useful auxiliary to national defence, even if it is altogether unsuited as an organisation for military purposes. The one great objection to clubs by



TARGET SHOOTING AT ZÜRICH, 1525

the less enlightened of their military critics may be summed up as follows: What is the good of independent people who shoot? If a young fellow wants to shoot, why should not he join the Volunteers, or the Yeomanry, and drill as well? This is a natural view possibly for the townsman to take, but it argues a scanty knowledge of the real conditions under which the bulk of our Volunteer force exists. In one of the counties which abut upon Middlesex there are about 225 parishes. There is a battalion of Volunteers belonging to the county, and having companies in various parts of it, but it would be an exaggeration to say that more than fifty of the parishes in that county can, owing mainly to geographical hindrances, contribute men to the Volunteer corps. The trouble and expense of bringing little parties of two or three men a long distance for instruction, and the difficulty to the men of finding the additional time required to come together at a centre, are almost insurmountable. It is equally out of the question to provide instructors numerous and ubiquitous enough to go to many small out-stations to teach the two or three whom it may be possible to gather together here and there. Both in towns and in the country the majority of Volunteers are young men in the employment of others, whose time is not their own, and who, in any case, get no special facilities or leave from work to attend drill. There are many the hours and times of whose occupations make it impossible for them to undertake regular drill, still less the training in camp which has of late been more and more recognised to be the most practical part of Volunteer instruction. A very large number of the best and keenest Volunteers give up the whole of their scanty annual holiday to camp; for others, who must take their holiday when they can get it, attendance at camp is out of the question. It is therefore vain to speak as if every able-bodied young man who chose was so circumstanced that he could belong to the auxiliary forces. This being so, what right has any organised military body to say that so far as its influence extends no one who is not in its own ranks shall fire a shot? Such a 'dog in the manger' policy is unreasonable, and can only be harmful. Fortunately this is by no means the general attitude of the

Volunteer force. A large proportion of existing rifle clubs use Volunteer or military ranges by permission, and it is well that it is so. How else should the retired Volunteer, who has served his time, and who, it may be, is an instructor of younger shots, how else should the old soldier or reservist, have the opportunity of handling a rifle? But it is not only the veterans who are attracted. The youngster who learns to shoot with effect is naturally ambitious to have more opportunities to shoot, and when he can handle a Service rifle is almost sure, if he can manage it, to join a Volunteer corps. If he should find himself out of work, his thoughts will naturally gravitate towards the Army. There are hundreds of keen Volunteers at the present time who would never have entered the ranks but that they had become interested in shooting. The slovenly pot-hunter is now almost extinct.

It is to be hoped that we may never again have occasion to ask the untrained patriotism of Great Britain to volunteer to go across the ocean to take part in active operations in Africa or anywhere else. But there can be no question that had opportunities for rifle practice been very much commoner than they are, the quality as soldiers of the large numbers of Yeomanry who have been raised, equipped, and hurried out to South Africa, would have been much higher than it actually was. More of them would have felt that in one department at least of their training they were well grounded. Many of those who did go out, having scraped through a test of shooting which hardly demanded any previous experience other than the use of a shot gun will give, lacked almost or quite all further opportunity for instruction owing to the absence of sufficient range accommodation close at hand at the depôts to which they were sent before sailing.

Both the late and the present Commanders-in-Chief, Lord Wolseley and Lord Roberts, have expressed their strong approval of the movement to popularise rifle shooting. It would be impossible under our peculiar conditions in this country of a voluntary army, and immense respect for the rights of private property, that any movement familiarising the public with rifle shooting in its double aspect of a pastime and an important factor in national defence and military training should not be of material service to the Army. It is interesting then to know that as a result of the rifle club movement, which dates from the 'Black December' of 1899, nearly 200 rifle clubs have been established and affiliated to the National Rifle Association, and several ranges of from 500 to 1,000 yards, on which the Service rifle can be used, have been established by and for rifle clubs. Those who have experience of the difficulty of setting up ranges for military practice will understand the great value of voluntary interest and assistance in this matter. When this country has all the troops that it could possibly require, both for national defence and for operations abroad; when it has provided ample range accommodation at all its military centres, small as well as great; and has given full opportunities for shooting, not only to those who are under arms, but to the men of the Reserve or the Militia, who are liable to be called up for service at any moment, then it will be time enough to say that voluntary associations of marksmen are things of no public utility whatever.

The chief obstacle perhaps at the present moment to the formation and prosperity of rifle clubs is the existence of the gun licence. It is indisputable that in the interests of public peace and safety, as well as for the prevention of poaching, the gun licence has been necessary, but it dates from a time when the only use of fire-arms was for shooting game or for arming troops or mobs. Shooting with the musket, as a pastime, can have given no great amount of satisfaction. There is need to maintain the old restrictions as regards indiscriminate shooting of game and the handling of fire-arms by incompetent or disloyal people. But why the man who for his own amusement wishes to make himself proficient in the use of our national military weapon should be taxed for so doing, any more than the cricketer or the golf player is taxed on the instruments he uses merely for his amusement, it would be difficult to say. For purposes of sport the gun licence and the game licence are readily paid, and afford to those who pursue their sport legitimately some degree of protection for it. No such motive holds in the case of military or target rifles. Many would like to see the use of the

Service rifle, and, indeed, of all rifles, for target purposes only, absolutely unfettered by a payment for licence. The proviso might be added that a police permit should be obtained as a certificate of character, and that on any abuse of the privilege being proved, a heavy penalty should be imposed, coupled with a prohibition to be allowed to take out a licence at all for a term of years. Volunteers at the present time are not liable for a gun licence in respect of the shooting in connection with their military training, nor is any attempt made to enforce on them the payment of the licence even where they practise on the range in plain clothes, and for their own amusement, so far as the writer is aware. Indeed, any interference in this particular would be quite unjustifiable.

The writer has grave doubts whether the shooting galleries which are to be found in connection with fairs and merry-go-rounds all over the country in summer-time, are not unduly privileged in the matter of the gun-licence. He has never heard of the casual loafer who pays a penny a shot having been 'run in' by the Excise for shooting without a licence, and if this were attempted the result would very quickly be the extinction of the amusement. There appears to be no sufficient ground for allowing to such concerns a privilege which is denied to a more serious, systematic, and useful form of the same sport, carried on not for gain, but for amusement and utility.

It is the County Councils that now reap the advantage of the licences taken out within their districts. We may well believe that if they were allowed an option in the matter, as they might well be, some of them, at least, would consent to remove the tax upon target-shooting. There seems every reason to think that the loss to their revenues would be almost nominal. In any county there can be few, if any, who take out the gun licence merely for the purpose of target - shooting, whereas certainly an appreciable number who might otherwise practise are now prevented from doing so by the cost of the licence, which bears especially hardly upon the wage-earning classes. It is well that steps have already been taken to reduce the pressure of the gun-licence upon the clubs. In 1900 it was decided by the Chancellor of the Exchequer that the tax should not be enforced upon rifles *bona fide* the property of a club affiliated to the National Rifle Association on terms sanctioned by the War Office, the rifles to be used only on the range of the club. But this concession hardly seems enough. It would appear that members may not convey these rifles to another range, as they must in shooting an out-match with another club, nor keep them at their own houses, without becoming liable for the licence. This can scarcely be considered a satisfactory state of things. A minor difficulty arises from the date at which gun-licences have to be renewed. The months between March and November practically comprise the rifle-shooting season, and gun-licences expire on July 31, so that for a single season's shooting two licences have to be taken out. This goes some way towards inflicting a double tax upon the target-shooter. The remedy is not easy to see, as the best date for the division of the year for sporting purposes is August 1, and indeed, it is not many years since Mr. Childers altered the date from January 1 on this account.

A further difficulty which affects not the clubs only, but the whole of His Majesty's forces, is that of the heavy cost of the ammunition for the Service rifle. It is one of the few drawbacks of the small-calibre rifle that, with smokeless powder and a compound bullet, as well as a solid-drawn brass case, its ammunition is more costly to manufacture than that of former Service rifles. *4l.* to *5l.* per thousand, though it may represent the actual cost of manufacture, is a heavy price to pay for the amusement of rifle practice.

Rifle associations and clubs may be divided into several classes. There are the large associations, such as exist in Scotland and Ireland, and in most of the Colonies. There are the Army Rifle Association and the Militia Rifle Association, which in their several spheres do excellent work. Then there are the County Associations, of which a list may be found in the annual report of the National Rifle Association, most of which have existed for many years, and which are for the most part associations mainly for the encouragement of Volunteer shooting. Such associations have usually, like the National Rifle Association, only a very small percentage of purely civilian members. There are such clubs as the English Twenty Club, which exists to keep touch with the best shooting Volunteers eligible to shoot in the International short-range match, and whose ramifications extend all over the country, and the very similar Scottish Twenty Club. There is also the English Eight Club, which performs a similar function for the Elcho Shield match. Scotland and Ireland have corresponding organisations. Of local rifle clubs, other than the County Associations, a few are large and important ones, of which the North London Rifle Club is the best known within the metropolis. These again, have very few members who are not, or have not been, Volunteers, or connected with one of the other Services. Nor must we omit to mention the Cambridge University Long Range Club, a rather small body which cultivates the extreme range of 1,100 yards, and has for many years held an annual two days' meeting, one of the most enjoyable events of the year to those privileged to attend it. There are also many smaller rifle clubs and associations, mostly of recent origin, and usually having some town, large or small, for a centre. A number of these are able by arrangement to use the Volunteer ranges at times when accommodation for them can be spared, and in such cases some of their members are usually Volunteers. A certain number of purely civilian clubs exist, and some of these have full-sized ranges of their own, and use the Service rifle. Others, which may be called miniature rifle clubs, have shorter ranges, sometimes under cover, and the shooting is done either with small rifles, firing quite a light charge, or the Service rifle, fitted with the Morris tube or with some other device for firing miniature ammunition through the barrel. There seems to be no reason why such clubs as these should not be extensively established, since the expense of making a safe range for these small weapons is very little, and, what is of still more consequence, the ammunition is very cheap. There have been some satisfactory instances quoted of late, in which youths, whose only experience of rifles was practising at a miniature range, have done very well when firing with the Service rifle at longer distances, in qualifying to go to South Africa with the Imperial Yeomanry, or on some such occasion.

The existence of a rifle club in a small place depends largely upon two factors. In the first place there must be someone to lead the movement who is active and willing, and will give time and trouble to organise it. It is of great advantage, too, if some owner or occupier of land close by is interested in the matter, and willing to help the club by providing a site on which they can practise. Where these two essentials are fulfilled there is usually little difficulty in setting up a club of one kind or another. Some sort of meeting of those interested is usually held to start the proceedings; rules are drawn up, and a subscription fixed at as low a figure as practicable. A committee is appointed, and, almost more important still, a secretary, upon whose individual exertions, good sense, and tact the prosperity of the club will mainly depend. Friends in the locality are usually asked to help start the club by subscriptions, and if the management is business-like, and if the secretary or some other competent person attends when the range is open, to superintend and give any necessary instruction, the club soon becomes a going concern. Lieut.-Colonel Crosse, the courteous and indefatigable secretary of the National Rifle Association, Bisley Camp, Brookwood, will always be pleased to give information or advice to those who think of starting rifle clubs.

We give at the end of the chapter the conditions for affiliation of rifle clubs to the National Rifle Association as approved in 1900 by the Secretary of State for War, and also a list of the clubs registered (pp. 536, 539).

We have already spoken of Swiss and Continental ranges, and of the equipment and club-houses, &c., with which they are so often fitted. The fact is that on the Continent shooting has been made almost an indoor sport, an occupation available just as much in wet as in dry weather; while it admits to some extent an opportunity for a picnic on occasions of matches, or of any shooting of special interest. One great advantage that Continental clubs enjoy is, as has already been said, that they have the custom of shooting on Sundays. On the other hand, they have no free Saturday afternoon. If rifle gatherings were tolerated after the hours of morning service in this country, as they are in the Protestant as well as the Catholic cantons of Switzerland, the opportunities which busy men have for shooting would be multiplied manyfold. In a country like Switzerland shooting, although a much valued sport, is that and something more. It is recognised to be a national necessity for the security of the country that it should be in every way encouraged; and since the population generally cannot shoot except on Sunday, and national security demands that they should shoot, Sunday afternoons are devoted to the purpose. It may well be doubted whether such a change would ever be sanctioned by public opinion in this country, unless shooting became recognised, under the stress, possibly, of some special national peril, as a work of real and standing necessity. In some parts of Great Britain (but certainly not in the north of it) a good many appear to hold the opinion that it would be desirable that shooting on Sunday should be recognised by the chief associations, but it cannot be said that this proposal has so far met with any general support. Sunday shooting was the rule in this country before the Reformation, and seems to have been to some extent revived 100 years ago, for in 1808 the author of 'Scloppetaria' expressed himself as follows: 'As for the Sunday practice and drill, which is objectionable in the eyes of some moralists, it may be again asked, whether it be not better that the bulk of the people should thus meet in a lively and healthful exercise to qualify themselves for becoming patriots and champions of liberty, than to assemble in public houses, taverns, and tea-gardens, exhausting the produce of their labours in drunkenness and debauchery? In those times, when it was enacted by law, that the Sunday afternoon should be appropriated to the practice of archery, do we find that the labouring orders were less virtuous or less religious than in the present day?'

Unfortunately, the difficulty of establishing ranges constantly increases as population spreads, and on the Continent, as in this country, people have further to go in order to enjoy the sport of shooting with rifles of any power. Bicycles and other means of locomotion now make distance of less importance than formerly ; but for club shooting, as for other things, it must be remembered that the time of the competitors is one of the most important considerations. The man who can find a spare hour to go down and shoot will almost certainly not be able to find the two or three hours which a journey by a particular train each way, probably with a walk at the end of it, will demand. It is no remedy to help with cheap tickets, or a grant of travelling expenses, where the time involved is such as to interfere with the man's ordinary occupation.

There are certain points which must equally engage the attention of the organisers of a rifle club, whether the shooting be with the full-sized rifle or on a miniature scale. One is to provide proper superintendence at all times while the shooting is going on. There should always be somebody on the spot responsible for the methodical carrying out of the shooting; to give the order to commence and to cease fire; to insist upon a strict observance of all precautions against accident; to serve out the ammunition; to see that carelessness or ignorance does not lead to the dangerous handling of the rifles.[1] These functions are performed in the Swiss clubs by the *schützenmeister*, a voluntary official who serves for a year or two, and is then replaced by another. His duties are not combined with those of the secretaryship of the club, which are of a different order. In this country it may be convenient to engage the services of a retired soldier, in his spare time, for the purpose. If so, he should be a man really interested in the work which he has to do. The same individual has another function, to give instruction, when required, to the beginner or young shot, and to teach not only the principles of aiming and firing, but the proper and safe manipulation of the weapon. He has, further, to superintend the registration of the scores, and to check, so far as he can, the correct-

[1] At many rifle meetings of Continental clubs, those waiting to shoot secure their turn by placing their rifles in a rack behind the firing point of the target at which they wish to fire. They thus 'squad' themselves, making a *queue* of rifles instead of one of men. By an admirable rule, all rifles not in use must have the breech left open.

ness of the marking. It is one of the great advantages of miniature ranges that a marker at the butts is not necessary, and that the score is recorded on the actual cardboard target used by each competitor, which can be examined at leisure if there is a doubtful shot, and which the fortunate man who makes a good score can take home and keep as a memento of his prowess. The shooting superintendent must further see that the targets supplied, or painted upon the iron plate, have their dimensions in accordance with those laid down, and that the shooting is done from the proper distance by each competitor, and the rules in every respect observed.

The attention of the club committee will have, at a very early stage, to be directed to drawing up some simple rules for the management of the range and the order of shooting. They must vary very much according to the different circumstances of each range and club. It is convenient to have certain times in the week, usually Saturday afternoons and evenings, and when the days are long, one or two other afternoons, when the range is open for a competition or for ordinary individual practice. There is no objection to the use of the range at any other time by individual members, on their paying the necessary expenses. If the club owns rifles, as many clubs do, it is necessary to have some place where they can be safely kept, and where they can be cleaned and looked after. If they exceed in number more than a very few, it becomes imperative to have a proper armoury, fitted with a bench for cleaning, and for doing any small adjustments or repairs. If either the caretaker of the range, or the superintendent of the shooting, live close by, he may be able to find the necessary accommodation in his house. In any event, the rifles will want constant attention. It is not wise to keep rifles in a building of a temporary kind, erected for that purpose on the range, and apart from other dwellings. Not only is there some risk of robbery, but if the roof happen to leak, or rain or snow to drive in through crannies, irreparable damage may be done in the course of a few hours. If a separate armoury is used, it should be a substantial building difficult to break into, really weather-proof, with good ventilation, and with a stove or some other means of warming it. It should be visited every day, and the rifles constantly looked over.

The amount of the entrance fee and subscription to be paid by the members is a matter to be determined entirely by the circumstances of the particular club. It is necessary, where all the members are not in a position to bear the whole cost of the cartridges for their own use, to have a fund through which ammunition can be supplied at less than cost price. Much interest is roused by an occasional competition for prizes. It is well to cultivate the feeling that the honour and satisfaction of making a good score are in themselves a reward. Any idea that it is not worth while for a man to do his best unless there is a substantial money prize to be won must be discouraged as 'bad form.' When money prizes are arranged, they may well be such as will to some extent meet the expenses to which the shooter is put in his practice. Handicap competitions are invaluable in bringing on the younger shots and encouraging the less skilful. Many clubs have very interesting competitions for a challenge cup three or four times in the season, or perhaps every month, and when this is done, a system is adopted by which, if there is not a general handicap, at all events the previous winners are penalised. The conditions for such a competition must vary according to the nature of the range, &c. It is well not to let the number of shots be too great, since this is all in favour of the old hand, and it is the young shot who most needs encouragement. Tournaments in which pairs of competitors meet and shoot against each other shoulder to shoulder give rise to much interest. Special prizes for the aggregate total made in a given number of the minor competitions may constitute a championship test. Medals or badges of a simple kind to mark the chief event of the year are attractive to many. In some clubs a little silver spoon of a special pattern, and costing a very few shillings, is the prize in a weekly or monthly competition. These matters depend largely upon taste, and still more largely upon finance. But the secretary should not fail to keep a special book in which to record the result of the shooting in all competitions of every kind. More interesting than individual competitions are the team matches, which can be arranged within the club itself or with neighbouring clubs. These afford an opportunity not only for the organising power of the captain (for a good captain is the first and foremost element in success in team shooting), but for mutual help on the part of the members, and are valuable as giving experience in shooting under circumstances and among surroundings different from those of the home range. The young shot who has a difficulty in coming to the top in individual competitions, is much encouraged if he finds himself selected as a useful team shot, and fairly holding his own among others.

There is much enjoyment to be had out of shooting even on quite a small scale, and it is perhaps in the stage of emergence from boyhood that shooting is more attractive than at any other time. The one thing important is that the weapon should answer to the helm, and respond to the care and skill with which it is directed. The common fault of shooting galleries is that even if the rifles are not badly sighted, they are allowed to get foul, and do not by any means do justice to the aim. It is very disheartening work to try to make fine shooting with them, though, on the other hand, the lucky fluke which comes at rare intervals is all the more satisfactory. The club rifles, then, should not only be kept in scrupulously good order, but should, if there is much shooting, be wiped out at intervals during the firing. As in all else, it is business-like management and attention to detail that will make the difference between success and failure in club management. To enlist the largest possible amount of support and sympathy; to meet the convenience, within reasonable limits, of every one; to apply rules for competitions with perfect fairness, yet always tactfully; to see that no detail of proper management is neglected; these are the things to make the difference between success and failure. Most of all, there should be that healthy rivalry, which will tolerate no unfairness, no taking of a mean advantage, and which is a better bond of union among members than anything else which can be devised. It is one of the pleasantest recollections of an old shot to call to mind days when he as a youngster received kind and tactful advice and help in his difficulties from older shots; and he will lose nothing if he, too, in his turn gives help to the youngster who needs it. There is a pretty story, which is said to be well authenticated, of some Maoris who were defending a 'pah,' or stockaded position, against an attack by white troops. Fire on both sides had been for some time in progress without much result. At last that of the attacking force slackened, and then ceased. The Maoris sent out to know what was the matter, and the reply was that the attackers had exhausted their ammunition; whereupon the Maoris, in a thoroughly gentlemanlike spirit, offered to share out their remaining ammunition, so that fighting might proceed on equal terms! This was perhaps rather straining the courtesies of war. But even among friendly rivals such feeling is none too common, and cannot be too much encouraged. There is room for it in shooting, as in all else. It is a wholesome state of things if a man feels that if he does a mean act, or takes a petty advantage, public opinion will be decidedly against him; and whether among friends in a club, or among strangers at a big gathering of riflemen, the same spirit should always prevail.

CONDITIONS FOR AFFILIATION OF RIFLE CLUBS TO THE NATIONAL RIFLE ASSOCIATION

In pursuance of the memorandum published by the Council of the National Rifle Association on January 16, 1900, and in consequence of the large number of applications received from persons desirous of establishing local rifle clubs, the Council have entered into communication with the Secretary of State for War, and having been deputed by him to deal with the question of the formation of rifle clubs, do now issue the following conditions for affiliation:

1. Every rifle club to be affiliated with the N.R.A. must consist of at least twenty subscribing members.

2. The annual registration fee of 1*l.* must be paid on or before March 31 in each year.

3. The rules and practice regulations of each club must be submitted to and approved by the N.R.A. No alteration in the above can be made without further approval.

4. Every rifle range must be approved by proper military authority.

5. Every rifle club must render to the N.R.A. on formation and before March 31 annually a nominal roll of its members for transmission to the G.O.C. the district in which the club is located.

6. Rifles and ammunition will be issued on repayment at vocabulary rates [1]—rifles, 64*s.* each; ammunition, 4*l.* 13*s.* a thousand—to each club in the proportion of one rifle to every ten members, and 100 rounds of ammunition per annum per member. Rifles thus issued become the property of the club and not of any individual member, and are only to be used on the range.

7. In addition Martini-Enfield rifles at 38*s.* each may be had in the proportion of 30 per cent. under the following conditions:—This further issue will only be made upon the condition that the Martini-Enfield rifles shall be returned if required in emergency by H.M. Government, the club being refunded the full price paid for the rifles less one-twelfth for each completed year since the date of issue, with a minimum price of one-fourth of the full price paid. An undertaking to comply with this condition will be required from each club before any issue is made.

8. The club rifles, when not in use, and ammunition must be stored in a place provided by the club for the purpose. On no account are club rifles or ammunition to remain in the possession of individual members.

9. Ammunition will only be issued at the firing-point, and on no account will individuals be allowed to take unexpended rounds away with them.

[1] These rates are subject to alteration.

CONDITIONS FOR AFFILIATION OF MINIATURE RIFLE CLUBS TO THE NATIONAL RIFLE ASSOCIATION

The National Rifle Association having been deputed by the War Office to deal with the question of the formation of rifle clubs, the following conditions have been drawn up for controlling the working of miniature rifle clubs associated to the N.R.A.

Any properly organised miniature rifle club is eligib e for affiliation on the following conditions:

1. That it shall have not less than twenty members.

2. That it shall undertake to pay an affiliation fee of 10*s.* per annum to the N.R.A.

3. The rules and practice regulations of each club must be submitted to and approved by the N.R.A. No alteration in the above can be made without further approval.

4. That it shall have a range or ranges of not less than 25 yards, which must be approved by military authority.

5. That on all occasions when the ranges are open for use by the members there shall be an authorised person in charge of the shooting, whose duty it shall be to see that the rules and regulations of the club are properly observed, and preferably such person should be capable of acting as instructor.

6. That the club shall not allow the use of any rifle or ammunition which does not conform with the following requirements:

Calibre.—Not to exceed ·320 bore.

Bullet.—Not to exceed 80 grains in weight.

Rifle.—Not to exceed 8 lb. in weight, except in the case of the Service rifle with Morris tubes.

Trigger.—Pull not to be less than 4 lb.

Butt.—To be of plain type without projections at toe or heel.

Sights.—Any except telescopic.

Magazine.—Repeating or magazine rifles shall be absolutely prohibited. Service rifles when fitted with Morris tubes shall not be considered repeating or magazine.

7. The N.R.A. miniature standard targets, recommended for club competitions are as follows:

	Bull	Inner	Magpie	Whole Target
Points . .	5	4	3	2
25 yards . .	1-in. circle	2-in. circle	4-in. circle	6-in. square
50 „ . .	2-in. „	4-in. „	8-in. „	12-in. „
100 „ . .	4-in. „	8-in. „	16-in. „	24-in. „

8. Every rifle club must render to the N.R.A. on formation and on or before March 31 annually a nominal roll of its members for transmission to the G.O.C. the district in which the club is located.

9. The club rifles, when not in use, and ammunition must be stored in a place provided by the club for the purpose. On no account are club rifles or ammunition to remain in the possession of individual members.

The Lords Commissioners of H.M. Treasury have sanctioned exemption from gun licence in respect of each rifle belonging to an affiliated club which is the property of the club and used only at the rifle ranges.

RIFLE CLUBS AFFILIATED TO THE NATIONAL RIFLE ASSOCIATION

Those marked (M.) are miniature rifle clubs. Those marked (m.) use miniature ranges as well as full ranges.

Rifle Club	Secretaries	
	Name	Address
Aberystwith	J. Davis	4 Bridge Street, Aberystwith
Albury (m.)	G. H. Coe	Albury, Guildford
Aldenham Park (M.)	C. Curston	Morville, Bridgnorth
Altcar	W. F. Huston	40 St. Paul's Road, Seacombe, Cheshire
Antony (m.)	Rev. J. A. Kitson	Antony Vicarage, near Devonport
Ascot	C. Deavin	Birch Cottage, Ascot
Ashdown	Norman W. Grieve	Ivy Chimneys, Tunbridge Wells
Ashington and District (m.)	J. Boutland	Ashington, Northumberland
Ayton	J. Chalmers	West Lodge, Ayton, Abernethy, Perthshire
Baden-Powell (M.)	H. Johnson, jun.	346 High Street, Chatham
Ballymena	David Adams	Glenmanus Place, Colleybacky Road, Ballymena
Barnsley and District	Richard Hoey	Eldon Street, Barnsley
Barry	F. P. Jones-Lloyd	74 Holton Road, Barry
Beefolds (Farnham) (m.)	Bryan Hook	Beefolds Churt, Farnham
Belfast Y.M.C.A.	J. Stewart	Y.M.C.A., Wellington Place, Belfast
Belper	Sergt.-Instructor P. McCarthy	Milford, Derby
Benenden	Thos. Weston	Standen Benenden
Bermondsey and Rotherhithe (M.)	M. Haig	Tower Bridge Hotel, S.E.
Birmingham	E. C. Tye	Havelock Road, Handsworth, Birmingham
Bishop Sutton (M.)	Tudor Harvey	Bishop Sutton, Chilton, Bristol
Bishop Auckland (M.)	W. A. Scarborough	Bishop Auckland, Durham
Bisley	F. G. Britten	Aldershot Brick Works, Aldershot
Bitton	Dr. F. W. S. Stone	Bitton R.C., near Bristol
Blandford and District	W. Haskell Short	The Shrubberies, Blandford

Rifle Club	Secretaries — Name	Secretaries — Address
Blyth	Robert Nicholson	Old Post Office, Blyth, Northumberland
Bournemouth	O. Palmer	Burley, Tregonwell Road, Bournemouth
Braintree	Armr.-Sergt. Bloomfield	55 Manor Street, Braintree
Bramshott and District (m.)	Mrs. Robb	Liphook, Hants
Bridgenorth and District	J. Bromley	Endon, Bridgenorth
Brighton Imperial (m.)	H. King	24 Lower Rock Gardens, Brighton
British Rifle Club, Alexandria	A. S. Preston	7 Boulevard de Ramleh, E.V.
Brough (m.)	R. Philipson	Brough, Westmoreland
Buckingham (m.)	Rev. Herbert Dale	Radclive Rectory, Buckingham
Burnham (m.)	W. Hyde	Shortland Villa, Burnham, Bucks.
Cairo, British	T. C. Macaulay	Cairo British R.C., Cairo, Egypt
Calder Valley	E. A. Dennis	9 Brunswick Street, Hebden Bridge
Central Presbyterian Association	J. R. Hunter	C.P.A., 12 May Street, Belfast
Charlton and Kidbrook (m.)	Lieut.-Col. Swinton	2 Charlton Park Terrace, Old Charlton
Chepstow and District	F. Hammond	27 Bridge Street, Chepstow
Chevening	H. S. King	Chevening Estate Office, Kent
Chirk (M.)	W. Parker	Chirk Castle Office, Chirk, N. Wales
Chiswick (m.)	C. W. Stuart	29 Cambridge Road, Gunnersbury
City of Newcastle (late St. George's) (m.)	R. Sheriton Holmes	5 Mosley Street, Newcastle-upon-Tyne
Civilians	G. B. Ince	St. Benet's Chambers, Fenchurch Street, E.C.
Clacton	J. Lee	Thorness, Marine Parade, Clacton-on-Sea
Clayesmore School (m.)	Alex. Devine	Clayesmore School, Enfield
Clevedon	George Rich	The London, Clevedon
Colchester	H. H. Light	North Hill, Colchester
Cork (M.)	S. H. Milner	6 Mount Verdon Terrace, Cork
Cranbourne	Walter West	Roseneath, Rochester
Crystal Palace (m.)	A. Scott Turner	39 Anerley Road, Upper Norwood
Dalmellington	Alex. Gillespie	Helen Bank, Dalmellington, Ayrshire
Dartmouth (M.)	H. Bastard	Fairfax House, Dartmouth
Deane (M.)	W. B. Webb	Oakley Station, Basingstoke
Deptford	J. H. Peppercorn	17 Deptford Broadway, Deptford, S.E.
Dore	Frank H. Slater	Wood Lea, Dore, Sheffield
Dorking (m.)	W. F. Porter	9 High Street, Dorking

Rifle Club	Secretaries: Name	Secretaries: Address
Douglas	G. Drinkwater	Isle of Man
Dover	A. E. Aldington	5 Cannon Street, Dover
Dublin Civil Service	Charles Reid	General Valuation Office, 6 Ely Place, Dublin
Dukinfield (M.)	F. Pym	19 Town Lane, Dukinfield, Cheshire
Dundee and District	J. McKinley Stronner	Thistle Cottage, Maryfield, Dundee
Dunrobin (m.)	W. R. Birnie	Sutherland Rifle Association, Golspie
Dunstan's College (M.)	Head Master	St. Dunstan's College, Catford
Durham School (m.)	F. E. Hewitt	35 South Street, Durham
Earls Colne	A. W. Woods	Burrows Road, Earls Colne, Essex
Eastbourne	G. E. Colville	Cradock House, Meads, Eastbourne
East London	G. Ellis	51 West Ham Lane, Stratford, E.
Ebo (M.)	B. Storey	West Street, Gateshead-on-Tyne
Enfield (M.)	J. J. Makings	1 Bury Villas, Southbury Road, Enfield
Enniskillen	R. H. Ritchie	Town Hall Street, Enniskillen
Epsom	G. F. Burgess	Upland House, Epsom
Exonian	H. A. Drew	Hillsborough Lodge, Pennsylvania, Exeter
Faculty of Advocates	Edwd. H. Robertson	The Advocates' Library, Edinburgh
Falmouth	Martin Furze	Glencoe, Falmouth
Faringdon	W. Tucker	Faringdon, Berks.
Felixstowe	G. F. Hulme, M.B.	Montague Road, Felixstowe
Felling and District Civilian	P. Lynn	Kenmir Street, Felling-on-Tyne
Godalming (m.)	R. Munday	Bridge Street, Godalming
Grayshott Hall (M.)	A. Ingham Whitaker	Grayshott Hall, Haslemere, Surrey
Greenock and District	J. Macgregor	26 Hamilton Street, Greenock
Guildford and District	F. E. Higlett	Onslow Street, Guildford
Guildhall (m.)	S. Knight, junr. H. C. Folkard	Guildhall Club, Newbury
Guisborough (m.)	G. H. Tamblingson	36 Fountain Street, Guisborough
Harborne	George Hart	Heathdale, Harborne, near Birmingham
Harrogate	R. A. Breare	Herald Office, Harrogate
Hartlepool (m.)	George Chambers	138 Durham Street, Hartlepool
Hastings and St. Leonards	J. Simmonds	Maisemore, Hastings
Helensburgh (m.)	J. Rennie	Wellcroft, Helensburgh
Henley-on-Thames	A. S. Stone	Market Place, Henley-on-Thames
Howick (M.)	J. Mansfield	Howick, Lesbury

Rifle Club	Secretaries: Name	Secretaries: Address
Huddersfield and District	J. G. Wilson	Huddersfield
Hull Patriotic (M.)	J. W. Fryer	4 Tynemouth Street, Hull
Inverness	D. Guy	36 Union Street, Inverness
Ivybridge	Major F. M. Eden	Ivybridge, S. Devon
Jesmond (M.)	H. J. Tyeman	13 Cavendish Road, Jesmond, Newcastle-on-Tyne
Kettering	A. N. Simmons	Bank House, Kettering
Ketton	Hubert Eaton	Ketton Grange, Stamford
Kolapore	J. S. Birkby sen.	2 Gordon Place, St. Luke's, Jersey
Langley Park	Chas. Narborough	Chedgrave, Loddon, Norwich
Langport	J. Kelly	Langport, Somerset
Latheron	J. R. Kennedy	Dunbeath, Caithness, N.B.
Leamington (M.)	B. S. Streeten	Tachbrook Road, Leamington
Leatherhead and District (m.)	Ronald Peake	Hovard House, Ashtead, Epsom
Lee District (M.)	Percy Henry	The Lee, near Great Missenden, Bucks
Leeds (m.)	A. Hutley	209 Cardigan Lane, Headingley, Leeds
Leicester (m.)	T. Fitchett	9 Welland Street, Leicester
Lewes	Stanley Morris	School Hill, Lewes, Sussex
Lewisham (m.)	J. G. Webb	Normanhurst, Bromley Road, Catford, S.E.
Liverpool	W. F. Huston	40 St. Paul's Road, Seacombe
London and South-Western Railway (m.)	C. E. Worsdell	Nine Elms Station
Louth and District Patriotic	H. S. Thatcher	42 High Holme Road, Louth, Linc.
Ludgershall	Dr. H. H. Williamson	Ludgershall, Andover
Manchester	W. Wilson	163 Gt. Ancoats Street, Manchester
Matlock and District (m.)	William Jaffrey	Matlock Bath, Derbyshire
Middlesex	C. Beagley	Custom House, E.C.
Midland	Q.M.S. Ault	Swanbank, Bilston
Millom	W. Hutchinson	26 Duke Street, Millom
Modbury (m.)	W. H. Trinick	14 Broad Street, Modbury, Devon
Neath Civilian	H. G. Hannabuss	2 Greenway Villas, Neath
Newburn	Thos. Armstrong	Working Men's Club and Institute, Newburn-on-Tyne, R.S.O.
Newlands Corner (m.)	G. Findlay	Newlands Corner, Merrow, near Guildford
Newport (m.)	W. Garland	Brookwood, Newport, Mon.
Norfolk Works, Sheffield	E. G. Dignan	Norfolk Works, Sheffield
Novington	C. Hall	The Cottage, Plumpton, near Lewes
Old Windsor (M.)	Rev. J. Kenmure Roberts	The Tapestries, Old Windsor

Rifle Club	Secretaries — Name	Secretaries — Address
Pewsey Vale (m.)	G. E. Goddard	Victoria House, Pewsey, Wilts
Pelton Fell (m.)	Norman Thornton	3 Whitehill Terrace, Chester-le-Street
Plymstock	P. E. Bateman	Plymstock, Plymouth
Polytechnic (m.)	W. J. Davies	309 Regent Street, W.
Portsmouth	W. H. Edwards	145 Walmer Road, Fratton
Ramsgate (m.)	Walter Keeley	Harewood, Crescent Road, Ramsgate
Reading (m.)	H. Child	101 Oxford Road, Reading
Redcar	W. H. MacKinley	11 Portland Terrace, Coatham, Redcar
Reigate	F. Humphrey	Avondale, Reigate
Revelstoke District (m.)	Rev. W. E. Roome	Revelstoke Rectory, South Devon
Rotherhams (M.)	A. H. Moore	Rotherhams R.C., Bull's Head Lane, Stoke, Coventry
Rottingdean	A. E. Coe.	Preston House, Rottingdean
Rugeley (m.)	Col. Wetherall	Rugeley, Staffs.
Saltash (m.)	H. Bulteel	Home View, Saltash, Cornwall
Scarborough Civilian	C. Edge Farr	94 Westborough, Scarborough
Seaton Sluice	T. W. Gibson	West Terrace, Seaton Sluice, Seaton Delaval
Sevenoaks Volunteer (m.)	Ralph F. Harrison	Bradbourne, Sevenoaks
Sheffield (m.)	W. Swift	University College, Sheffield
Sheffield, Hallamshire, and Oughtibridge	H. Auty	66 Queen Street, Sheffield
Shere (near Guildford) (m.)	F. E. Bray	17 The Boltons, S. Kensington
Slough (m.)	G. Sargeant	176 High Street, Slough
Southend-on-Sea	J. W. Picton	Municipal Buildings, Clarence Road, Southend
South London	Capt. R. P. Mortlock	46A Pall Mall, S.W.
South Shields (m.)	R. P. Fernandez	20 Salmon Street, South Shields
Strathearn	A. Gibson	Union Bank House, Crieff, N.B.
Spilsby	Bennett Langton, jun.	Langton Hall, near Spilsby, Linc.
Stevenage (m.)	Ruthven Trendall	The Rowans, Stevenage
Stockton	Rev. B. M. Keymer	Stockton Vicarage, Wakefield
Stokesley	H. A. Hunter	West Row, Stokesley
	F. Wardell	The Villas, Stokesley
Stour Valley	L. R. Tippins	Mistley, Manningtree, Essex
Streatham and Stainton (M.)	A. E. Wolfe-Barry	Streatham House, near Darlington
Tenterden	A. J. Letchford	West Cross House, Tenterden, Kent
Three Towns and District	G. Elliot Square	10 Princes Square, Plymouth
Tillington	Stanley Clark	River House, Petworth, Tillington
Torquay (m.)	Edwin Smith	Livermead House, Torquay
Totnes	F. W. Hainthorpe	Northcote, Totnes

Rifle Club	Secretaries: Name	Secretaries: Address
Tring (m.)	Herbert Grange	Tring Grove, Tring
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LIST OF BOOKS

The following are some of the books which have been quoted, referred to, or consulted by the writer in connection with the present work. For an almost complete list of works on the subject of shooting the reader is referred to Mr. Gerrare's Bibliography mentioned below:—

Anderson, R. To hit a Mark as well upon Ascents and Descents as upon the Plain of the Horizon: Experimentally and Mathematically Demonstrated. London, 1690.

Angelucci, Angelo. Catalogo della Armeria Reale. Turin, 1890.

Anonymous. The Perfection of Military Discipline, after the newest Method, as practised in England and Ireland. London, 1690.

—— The British Soldier's Guide and Volunteer's Self-Instructor. London, 1808.

—— Volunteer Rifle Corps, by 'A Rifleman.' London, about 1860.

—— Arms and Explosives. London, 1892–1900.

—— Le Fusil à Répétition Mauser, Direction et Administration. Liège, 1900.

—— Memoir of William Ellis Metford. London, 1900 (privately printed).

Baker, Ezekiel. Remarks on Rifle Guns. London, 1800.

Bashforth, Francis. Account of Experiments made with the Chronograph. 1865–90.

Beaufoy, Col. ('a Corporal of Riflemen'). Scloppetaria: or Considerations on the Nature and Use of Rifled Barrel Guns. London, 1808.

Bellay, Gen. W. de. Instructions for the Warres, amply, learnedly, and politiquely discoursing the Method of Militarie Discipline. Translated by Paul Ive. London, 1589.

Boucher, John. The Volunteer Rifleman and the Rifle. London, 1860.

Bourne, William. Arte of Shooting in Great Ordnaunce. London, 1587.

Bury, the Viscount, Lieut.-Col. Manual of Rifling and Rifle Sights. London, 1864.

Busk, Hans. The Rifle and How to Use It. London, 1858.

—— Handbook for Hythe. London, 1860.

Campbell, Walter, Captain. The Old Forest Ranger. London, 1842.

Carver, Dr. Wm. F. The Life of Dr. Wm. F. Carver. Boston, U.S.A., 1878.

Chapman, John Ratcliffe. Improved American Rifle. New York, 1848.

Cockle, Maurice, J. D. A Bibliography of English Military Books up to 1642, and of Contemporary Foreign Works. London, 1900.

Cope, Sir Wm. H. The History of the Rifle Brigade. London, 1877.

Coutau, Sigismund. Archives de la Société de l'Arquebuse. Geneva, 1872.

Deane. Manual of the History and Science of Fire-arms. London, 1858.

Douglas, Sir Howard, Bart., Lieut.-Gen. A Treatise on Naval Gunnery. London, 1851.

Espinar, Alonso Martinez de. Arte de Ballestería y Montería. Madrid, 1761. (Original edition, 1644.)

Forsyth, Lieut. James. The Sporting Rifle and its Projectiles. London, 1863.

Foulkes, A. Glyndwr. The Theory and Practice of Target-shooting. London, 1895.

Fremantle, Hon. T. F. Notes on the Rifle. London, 1896.

Gaya, Louis de. A Treatise of Arms. London, 1680.

Gerrare, Wirt. A Bibliography of Guns and Shooting. London, 1896.

Gheyn, Jacob de. The Exercise of Armes for Calivres, Muskettes, and Pikes. The Hague, 1607.

Gould, A. G. Modern American Rifles. Boston, U.S.A., 1892.

Greener, Wm. The Gun. London, 1835.

—— The Science of Gunnery. London, 1846.

—— Gunnery in 1858. London, 1858.

Greener, W. W. The Gun and its Development. London, 1896.

Grose, Francis. Military Antiquities respecting a History of the English Army from the Conquest, &c. London, 1786.

Halford, Sir H. St. John, Bart., Col. The Art of Shooting with the Rifle. London, 1888.

—— Lecture upon the 'New Service Magazine Rifle.' Divisional Printing Office, Aldershot, 1888.

Hanger, General George. To all Sportsmen, Farmers, and Gamekeepers: above Thirty Years' Practice on Horses and Dogs, &c., &c. London. 1816.

Heaton, Capt. Notes on Rifle Shooting. London, 1864.

Jähns, Max. Entwicklungsgeschichte der alten Trutzwaffen. Berlin, 1899.

Jervis, Capt. Jervis-White. Our Engines of War, and How we got to Make them. London, 1859.

Jewitt, Llewellyn. Rifles and Volunteer Rifle Corps. London, 1860.

Kromar, K. E. von. Repetier-automatische Handfeuerwaffen der Systeme Ferdinand Ritter von Mannlicher. Wien, 1900.

Leech, Arthur Blennerhassett. Irish Riflemen in America. London, 1875.

MacDonell, J. R. The National Rifle Association, 1859–1876. London, 1877.

Marks. Edward C. R. The Evolution of Modern Small Arms and Ammunition. London, 1898.

Mason, Richard Oswald. "Pro Aris et Focis": consideration of the reasons that exist for reviving the use of the Long-bow with the Pike. London, 1798.

National Rifle Association. Annual Reports, 1860–1900. London.

Official. Text-book for Military Small Arms and Ammunition. War Office, 1894.

—— Instructions for Selection of Sites for, and Construction of Rifle Ranges. War Office, 1901.

Ordnance Department U.S. Army. Small Arms, 1856. Reports of Experiments with Small Arms for the Military Service, &c. London, 1857.

Phillips-Wolley, Clive. Big-game Shooting (The Badminton Library). London, 1894.

Polygraphisches Institut, Zürich. Festgabe auf die Eröffnung des Schweizerischen Landesmuseums in Zürich. Zürich, 1898.

Plat, Sir Hugh. The Jewell House of Art and Nature. London, 1594.

Rifle Conference, The. Report and Proceedings, &c. London, 1864.

Robins, Benjamin. Mathematical Tracts of the late Benjamin Robins, Esq., containing his New Principles of Gunnery, &c. London, 1761.

Rumford. Life and Works of Benjamin Thompson, Count Rumford. London, 1876.

Russell, W. H. Rifle Clubs and Volunteer Corps. London, 1859.

Schmidt, Rudolphe. Armes à Feu portatives. Bâle, 1889.

Scoffern, J. Projectile Weapons of War and Explosive Compounds. London, 1859.

—— The Royal Rifle Match on Wimbledon Common. London, 1860.

Scrope, William. The Art of Deer-Stalking. London, 1847.

Smythe, Sir John, Knt. Certain Discourses concerning the formes and effects of divers sorts of weapons, &c. London, 1590.

Tartaglia, Nicolas. Three Bookes of Colloquies concerning the Arte of Shooting in great and small peeces of Artillerie, &c. London, 1588.

Teasdale-Buckell, G. T. Experts on Guns and Shooting. London, 1900.

Tennent, Sir J. Emerson. The Story of the Guns. London, 1864.

Thierbach, M. Geschichtliche Entwickelung der Handfeuerwaffen. Dresden, 1899.

Tippins, L. R. ('A Marksman'). Modern Rifle Shooting. London, 1895.

Tippins, L. R. ('A Marksman'). Modern Rifle Shooting in Peace, War, and Sport. London, 1900.

Van Dyke, Theodore S. The Still Hunter. London, 1883.

Walker, Arthur. The Rifle, its Theory and Practice. London, 1865.

Walsh, J. H. ('Stonehenge'). The Shot-gun and Sporting Rifle. London, 1859.

—— The Modern Sportsman's Gun and Rifle. London, 1884.

Wheeler, C. A. Sportascrapiana. London, 1868.

Whitworth, Sir Joseph, Bart. Miscellaneous Papers on Mechanical Subjects. London, 1858.

—— Ditto. Guns and Steel. London, 1878.

—— Papers on Mechanical Subjects. Part II. London, 1882.

Wilcox, C. M. Rifles and Rifle Practice. New York, 1861.

Wilder, Salem. Rifles and Rifle Shooting. Boston, U.S.A., 1892.

Wilkinson, Henry. Engines of War. London, 1841.

Young, Stamford Sheridan. The Three Rifles. London, 1878.

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