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Suggestions for Improving Artillery Fire, Combined With an Explanation of Captain Scott's System of Sighting Guns

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Admiral Sir FREDERICK W. E. NICOLSON, Bart., C.B., Vice-President, in the Chair.

SUGGESTIONS FOR IMPROVING ARTILLERY FIRE, COMBINED WITH AN EXPLANATION OF CAPTAIN SCOTT'S SYSTEM OF SIGHTING GUNS.

By Captain L. K. Scott, R.E., Instructor in Fortification, Royal Military College.

I have the honour to bring to your notice this evening some suggestions for the improvement of artillery fire, consisting of a new system of sighting ordnance invented and proposed by me some seven or eight years ago for introduction into the Service, together with other suggestions not immediately connected with sighting.

In order to make the value of this system of sighting clear to your minds, I propose to begin my lecture by explaining the method of applying the rules for shooting with accuracy, when employing: 1. The rifle sights; 2. Service sights for ordnance; 3. The revolving and telescopic revolving sights proposed by me, and to compare the relative advantages of one set of rules with the other.

Before proceeding to explain the proposed system, I must crave the indulgence of those Artillery Officers who may be honouring me with their presence for trespassing on ground so essentially their own, and for entering into elementary details so familiar to themselves, yet necessary for the elucidation of my subject to the uninitiated; and I feel sure when they appreciate the advantages of the principles set before them, they will not only co-operate with me in my endeavours for the good of the Service, but they will be the first to hail with delight a system of sighting which not only simplifies the instruction to be imparted by them to their men, but increases enormously the destructive powers of their artillery.

To begin with the Martini-Henry rifle sights. In shooting the infantry soldier has to contend with four causes of error :—1. Drift; 2. Wind; 3. Sun; 4. Inclination of the sights. *Drift* is the deviation of the shot due to rifling. *Wind*, according to its direction, causes the bullet to be deflected from its course to the right, or to the left, or it increases or diminishes the range. *Sun* causes the firer to take a false "line of sight." *Inclination of the sights* causes the line of sight to be taken across the axis of the piece, and consequently the bullet to go on that side to which the sight is inclined, and short.

How are these four causes of error remedied by the *Infantry soldier?* 1 and 2. Drift and wind are obviated by using the wind gauge; 3. Sun by blackening the sights, and by care in aiming; 4. Inclination of the sights. The error due to this cause is entirely under the control of the Infantry soldier, because he can ensure the verticality of his sights by turning the rifle round in his shoulder. Hence, theoretically speaking, the error due to inclined sights is completely eliminated by the Infantry soldier. It follows, therefore, that for him to shoot with accuracy, he must apply practically to his sights certain rules which embody the remedies for the errors in shooting explained above.

These rules are applied mechanically by the Infantry soldier in the following way:—1. Adjust the sight to the correct distance; 2. Keep the sights upright by turning the rifle round in the shoulder till they are vertical; 3. Take a correct line of sight, which will take into account "wind" and "drift." To get him to comprehend and to apply these apparently simple mechanical rules to his rifle, he must have much theoretical instruction and much practice in shooting. With a view to making the *Infantry* soldier efficient, he has at least 8 days' theoretical instruction, and fires 90 rounds yearly. Should, however, any man not become efficient with this amount of training, he is liable to have any further amount of theoretical instruction, and to fire another 90 rounds. *The Infantry soldier therefore fires at least 90 rounds per annum to make him efficient in the use of his rifle.*

I will now proceed to explain the theory of Artillery sights. The theoretical principles involved in sighting ordnance are similar to those involved in sighting rifles, but the rules required for the gunner to make accurate shooting are far more complicated, and far more difficult to understand and to apply, than the rules for aiming the rifle. The Gunner ought, therefore, to require far more theoretical instruction, and far more practice in shooting than the Infantry soldier to teach him to fire with accuracy. We shall see that he has far less. For accurate shooting the Gunner has to contend with 5 causes of error instead of 4:—1. Drift; 2. Wind; 3. Sun; 4. Having to aim at distant objects not clearly seen by the naked eye; 5. Inclination of the sights due to the gun-wheels not resting on a level platform.

How does the Gunner provide against these 5 causes of error? 1. *Drift* is partially obviated by fixing the tangent sight on the gun at the permanent mean angle for rifling with the vertical. 2. *Wind* is allowed for by the "deflection scale," which corresponds to the wind gauge in the rifle. 3. *Sun.* The effect of the sun has been diminished of late in the 13-pr. by employing an eye-hole instead of a notch in the tangent sight. Some provision to obviate this defect could and should be made. It is obviated in Scott's sights by the use of a telescope, and by covering the foresight with a tunnel as in the 13-pr. breech-loader. 4. *Having to aim at distant objects not clearly seen by the naked eye.* This defect is not so applicable to the Infantry soldier as it is to the Gunner, because the former fires at much shorter ranges than the Gunner. No provision is made for assisting the Gunner to aim at objects which are beyond the clear vision of the human eye, and consequently he fails to extract the best shooting qualities of the gun because he cannot see to aim at objects at distances equal to the range of the gun. *Hence a telescope is an absolute necessity.* 5. *Inclination of the sights.* With the Infantry soldier this defect is remedied by his placing the sights into an upright position, which is accomplished by his turning the rifle round in the shoulder till they are vertical. This simple method of obviating the great errors due to the inclination of the sights, naturally cannot be carried out in the same manner by the Gunner, because he cannot twist his gun round in his shoulder.

This *Inclination of the sights* is a constant source of error and annoyance to the Gunner, because he has to make complicated calculations to remedy it, and is therefore a permanent defect in the present system of sighting. When he aims with a "line of sight" taken over inclined sights he no longer aims directly over the axis of the piece but across it. Hence he loses that command or control over the axis of the piece which is indispensable for accurate shooting, and which the infantry soldier possesses by having the power to turn his sights into a vertical position at will.

What then must the Gunner do to regain this command over the axis of the piece which he loses by his sights being inclined? He must calculate how much the notch of the tangent sight has been laterally removed from the vertical by the sight being inclined, and give this amount in "deflection right" or "left" to the notch of the tangent sight. Then if he apply this calculated correction to the tangent sight, he will regain, *according to the correctness of his calculation*, the command over the axis of the piece which he had lost by the inclination of the sights, because the notch is supposed to have been brought again back into the same position vertically over the axis, which it held when the sight was upright. A "line of sight" then taken over the notch and the tip of the foresight will enable the firer to direct the axis in any required direction.

How is this error due to inclined sights calculated in the field by the Gunner? Let us suppose, by way of example, that the range is 4,000 yards, gun-wheels resting on ground sloping to the *right*, and that a strong wind is blowing from the *right:* 1. No. 1 has first to find the elevation in degrees due to 4,000 yards range, say 9°, and to adjust his sight to 9°. 2. There is a strong wind blowing from the *right*, which will force the shot to the *left*. He must therefore counteract this effect of the wind by giving deflection, which he has to remember is "right deflection." How much right deflection is to be given? This can only be determined by those who have had great experience in actual practice in shooting. Suppose 10′ the correct amount of deflection, No. 1 gives 10′ "right deflection" to the notch of the tangent sight. 3. The *sights are inclined to the right.* The shot will therefore go to the *right* of the intended direction, and short. No. 1 must calculate the "deflection" required to counteract the error of the shot to the *right*, and then to remember that he is to give *left* and not right "deflection," otherwise the shot would go twice as much to the right as it would if no correction had been applied.

How does No. 1 calculate the required "deflection?" He uses Fitzroy's indicator, to find out how many inches the lower wheel is below the upper one, or he places the rammer on the upper wheel and over the lower one, holding it, as far as he can judge by the eye, in a horizontal position. He then estimates the number of inches which the lower wheel is below the upper wheel, say 5 inches. He then applies the following rule:—"*Multiply the difference of level of the* "*wheels in inches by the angle of elevation for the right or left deflection.*" The angle of elevation for 4,000 yards is say 9°. Therefore $9 \times 5 = 45'$ left deflection. But there being a strong wind from the right, which will blow the shot in the opposite direction to that caused by the sight being inclined to the right, he has to remember that a correction of 10′ *right* deflection has to be subtracted from the 45′ *left* deflection already calculated to counteract the effect of inclined wheels. Therefore 45 left −10 right=35′ left deflection as the correct "line of sight," under the above conditions. No. 1 then aims at the mark and the gun is fired.

If the correction has not been accurately made, the shot does not strike the mark, and consequently another calculation has to be made in the following manner: He guesses the distance to which the shot has fallen to the right or left of the mark, which say is 20 yards to the *right*. He then applies the following rule:—"Multiply the esti-"mated deviation in yards by 36 and divide by $\frac{1}{100}$ of the range." Therefore $\frac{20 \times 36}{40} = 18'$ deflection. No. 1 has then to remember that the 18′ deflection found must be *left* deflection, which must be added to the 35′ *left* deflection already given to the deflection scale of the tangent sight for "wind" and "inclination of the wheels." Therefore 35′ left +18′ left =53′ left deflection is to be given to the sight. If this be found not to be correct, the same calculation will have to be re-made.

Unfortunately this correction will not ensure the mark being struck, because when a gun is fired on the natural surface of the ground another element of error creeps in after every round which *should be* but is never taken into account, viz., *the further inclination of the sights, from the lower wheel becoming more and more imbedded in the earth after each recoil.* These ever-varying alterations in the inclination of the sights after every round, however small they may be, necessitate for accurate fire the continual remaking of these mental calculations. Therefore the calculated and applied corrections for the first round from one gun are of very little use for a second round from the same gun, and unless the rules for calculating the corrections for each source of error as it crops up, be applied to each gun after every round, it will be *mechanically* impossible for the second shot with a field gun to strike the mark, even should the first have done so. Therefore, for absolutely accurate fire, if there be 100 rounds fired from 100 guns, 100 mental calculations will have to be made.

By referring to Major Ellis's table of shooting, it will be perceived that the "deflections" vary for every round fired; whereas in the table of the shooting in France at 5,100 yards, with the telescopic revolving sight, the "deflections" remain the same throughout for all the rounds, whatever may have been the inclination of the wheels. I would ask, is it likely that a man who is being fired at by the enemy can and will make those mental calculations on the spur of the moment? I should say that this is highly problematical. Hence the futility of the present system of sighting.

From what has been said, it is evident that the rules necessary to enable the Gunner to shoot with *accuracy* with the service sights are far more complicated and far more difficult to apply in practice than those for the Infantry soldier.

The Gunner ought, for the above reason, to be more intelligent, more theoretically instructed, and more exercised in shooting than the Infantry soldier. For the Infantry soldier to learn to apply his simple rules for shooting, it is considered necessary that he should fire away at least 90 rounds per annum, and be constantly trained in theoretical instruction. It stands to reason, therefore, that the Gunner, whose rules for shooting are *infinitely* more complicated than those of the Infantry soldier, on account of not being able to place the gun-sights into an upright position, should have at least the same amount of rounds and the same amount of instruction as the Infantry soldier. As a matter of fact, the Gunner has very much less—only, I believe, 120 to 200 rounds per battery of six guns being allowed, or an average of 3 or 4 rounds per man of the 60 men required for working the guns, all of whom, in case of casualties, certainly ought to be able to shoot, one as well as the other. How can a Gunner possibly appreciate all the errors inherent in his system of sighting, or practically learn to apply the rules for their correction, by merely firing away 3 or 4 shots per annum? You might as well expect a man to become a good sportsman by his letting off a fowling-piece three or four times yearly.

In warfare, the sole object of firing off a rifle or gun is to kill some one each time that it is discharged. To perform its function it must be treated according to definite rules which, to be learnt, require a definite amount, and nothing less than this definite amount of practice. The definite amount, which of course varies with different individuals, should only be reached when perfection is attained.

Is not a system of Training illogical, unpractical, and incomplete, which assigns and apparently countenances different degrees of perfection for the Infantry, Cavalry, or Artillery, in the use of a weapon which has but one object, namely, *to kill?* It is an extraordinary anomaly that the Infantry man should fire 90 rounds yearly while the Cavalry man, who has the same kind of firearm, should only fire 40 rounds, and that 4 rounds are considered sufficient for the Gunner. It seems absurd that the Cavalry man or Gunner should not be expected to kill his man as often as the Infantry soldier—this being the obvious reason for firing off his weapon. It is treating a firearm as it were a toy, or merely as an addition to his uniform. Fixed bayonets and drill will not win a battle now-a-days against the rifle![1]

I have been told by Artillery Officers that their men do not have half enough instruction in "Laying" and "Aiming" guns, nor half enough practice in shooting. It is unfortunate that it should be so, but it cannot be helped. The duties of the Gunner are so multifarious,

[1] This has been lamentably and prominently brought to our notice by our reverse at the Majuba Hill since the delivery of this lecture.

and he has so many other things to learn besides, that he cannot devote more time than he does already to acquire a thorough knowledge of his system of sighting, *though it is the most important part of his training*; and again the State, on the score of expense, is not prepared to smooth his path by giving him sufficient opportunity of learning it practically by the expenditure of more than the regulation allowance of shot and shell.

What then can be done to make the Gunner more efficient in the "Laying" and "Aiming" of guns *without the expenditure of more shot and shell?* If we analyse the question, we can trace the cause of all his difficulties in "Laying" a gun to his *faulty system of sighting*, which does not permit of his placing his sights at will into an upright position, and to the *want of sufficient ammunition* for testing *practically* the result of his "laying."

The difficulty of "laying" guns can be obviated by giving him a system of sighting which will enable him to place his sights into an *upright position*, and the want of sufficient shot and shell for testing his "laying" may be supplemented by the introduction of a metal tube into the bore of the gun, which would allow of small size ammunition or even bullets being fired in combination with his drill previous to the annual practice of shot and shell.

The system of sighting invented by me, which I am about to describe, will not only remove all difficulty in "laying," but will enable the Gunner to become thoroughly efficient in shooting with no more than the present regulation amount of ammunition and training at his disposal.

I hope to be able to show by theory and by actual practical results, how, with a minimum of intelligence, with less instruction, with less expenditure of time and ammunition, with far less trouble to the Instructors and to themselves, Gunners can be made to extract the best shooting qualities of their guns, and to shoot as a whole about 10 times better in the field than they can at present with the service sights.

The system of sighting which I propose to bring to your notice consists in making sights for ordnance capable of revolution about an axis parallel in every direction to the axis of the gun.

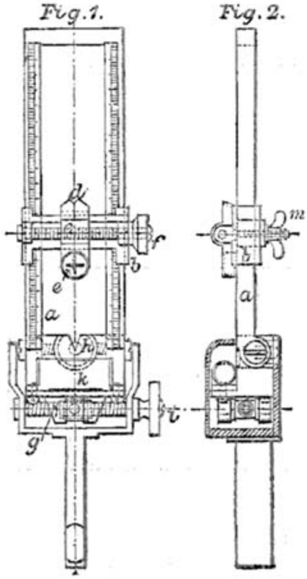
This revolving movement may be created by automatic arrangement on the principle of the pendulum, with the centre of gravity of the system of sighting below the axis of revolution; or it may be created by mechanical adjustment with the centre of gravity of the system of sighting above the axis of revolution.

The object of my invention is—1. To dispense with the errors of fire due to the inclination of the service sights when the gun-wheels are not on the level, by making the sights (back or fore) capable of being turned back again into the same position with reference to the vertical which they occupied when the gun-wheels were on the level. 2. To enable the firer to correct errors in range and direction by mechanical adjustments, instead of by the present method of calculation. 3. To give the firer complete command over the axis of the piece under all conditions. 4. To simplify the instruction required to be imparted to the Gunner for the use of the service sights, by converting mentally calculated arithmetical corrections for "deflection" into mechanical adjustment; and, finally, to dispense with all the defects and causes of error in shooting inherent in the present system of sighting.

The principle of my system of sighting consists in giving to sights a third movement in addition to the two movements already existing in the present system of sighting. The two movements of the present sights consist in a horizontal movement for giving "deflection," and in a vertical movement for giving the "angle of elevation." The additional third movement in my system of sighting consists in causing the two above-mentioned movements of the service sights combined, to revolve together about an axis parallel in every direction to the axis of the gun.

No sight without these three above-mentioned movements, involving as they do the theoretical principles necessary for a true sight for guns, will give the firer complete command over the axis of the piece. I have therefore embodied these essential theoretical principles mechanically in sights for ordnance generally, and I designate sights made on these principles "Revolving sights;" and where a telescope is used to aid the vision "Telescopic Revolving sights."

Fig. 1. Fig. 2.



I will now proceed to describe how I have applied these principles mechanically in the example illustrated in the accompany drawing. Fig. 1 shows the front elevation of a revolving backsight fitting into the socket in the gun of the service sight together with the interior construction of the same; Fig. 2, the side elevation of the same; Figs. 3 and 4, Plate I, the side and front elevations of a telescopic revolving sight. *a*, Fig. 1, is a hinged flap graduated for different ranges, and fitted with a slider (*b*) also graduated for "deflection," which can be set at the proper elevation on *a*; *c* is a traveller containing the notch *d* and eye-hole *e* of the backsight, which can be made to travel by the screw *f* for the purpose of giving the required "deflection". The flap *a*, Figs. 1 and 2, is hinged to an arm (*g*), both of which are made to revolve together round a hollow centre (*h*) by turning the screw (*i*), for the purpose of placing the sight into an upright position when the gun-wheels are not on the level. The hollow centre (*h*) and the levelling screw (*i*) are fixed to the frame; (*m*) is the clamping screw of the slider (*b*). The stem of the sight fits into the socket in the gun; (*k*) is a level to adjust the verticality of the sights, and is fixed on the sight in a position at right angles to the axis of the piece. The whole of the interior construction is covered up, leaving merely the bubble exposed to view.

To use the Revolving Sight.—For the sake of comparison let us take the same conditions which I have already taken in the example for illustrating the working of the service sights, and see how this is managed with the revolving sight. Range 4,000 yards; gun-wheels on ground sloping to the *right;* strong wind from the *right.*

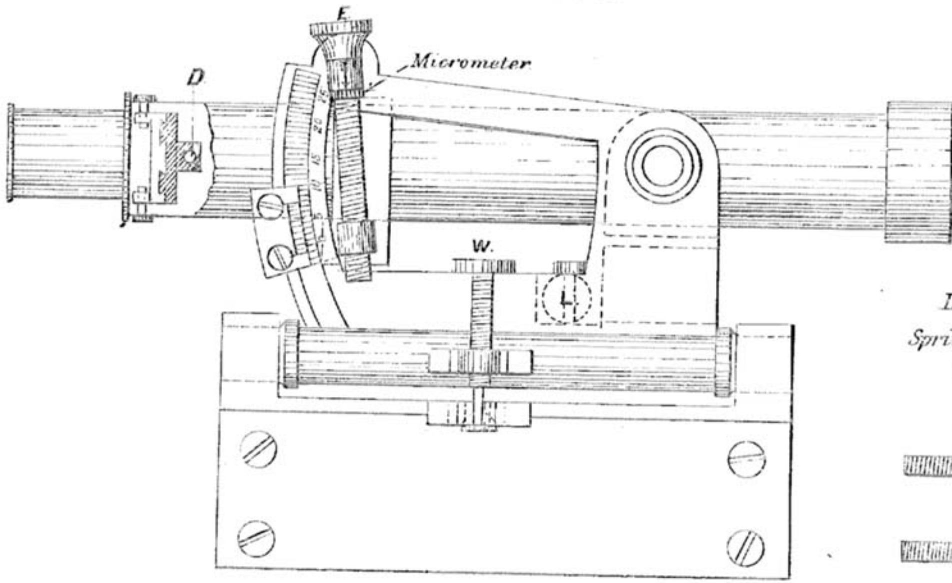
Let us take for example a *battery* of artillery about to fire at an object:—1. Adjust the sliders to 9° elevation; 2. Give 10′ right "deflection" to counteract force of wind; 3. Level the sights to dispense with the inclination of the wheels; 4. Aim; 5. See that the bubbles be in the centre, if not bring them to the centre and correct the aims; 6. Fire one gun only, the Nos. 1 of the remaining five guns of the battery looking over their sights and watching for the point of impact of the shot from the gun that is fired. If this trial shot of No. 1 gun hit the mark, the shots of the remaining guns of the battery firing at the same range, will also go in the required direction. But if the shot do not strike but fall to the right of the mark, the Nos. 1 of the remaining five guns, who, as before explained, are watching for the point of impact, will at once move the traveller (*c*) of the slider (*b*) by means of the screw (*f*) to the left until the notch, the tip of the foresight, and the point of impact of the shot are in line. This operation corrects mechanically the error in direction of the shot, and shows at once the amount of deflection to be given. It is, therefore, only necessary to turn the guns laterally by means of the trails, and to aim at the object with this corrected "line of sight," and the shots will travel in the required direction.

Of course, the No. 1 of the gun which has fired the trial shot must borrow and apply to his sight this corrected "line of sight," so that when this gun is again fired all its succeeding shots will go in the required direction. Fig. 5 shows how the corrected "line of sight" is obtained by the deflection scale of the "revolving sights."

This very simple mechanical process[1] for finding the correct "line

[1] This is infinitely superior to the German method of finding the range by trial shots. They are supposed to require 12 shots to attain this end, whereas 1, or at

Side Elevation.



Front Elevation.

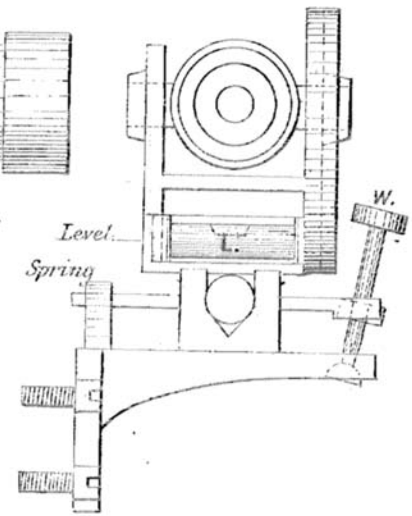
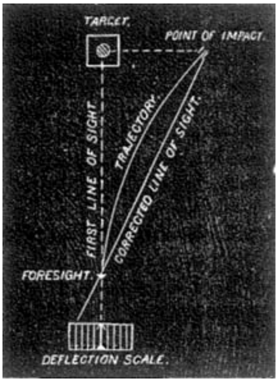


Diagram in plan explanatory of the process of correcting the "Line of Sight" of the Telescopic Revolving and the Simple Revolving Sight for the Error in Direction.

Fig 5.



"of sight," as compared with the complicated arithmetical method in use for the service sights, demands only sufficient intelligence on the part of the No. 1 to turn a screw in the right direction, and sufficient training to enable him to take a correct aim. In fact, after a few moments of practical instruction, any uneducated Hindoo, Japanese, or Chinaman who could aim, would be capable of performing the necessary operation just as readily as the most intelligent European, and the chances are that the result would be far more accurate than as at present obtained by calculation by the best trained soldier. This method, which allows of the correct "line of sight" being found for any number of guns by *one trial shot from one gun*, is an incalculable advantage, because after the correction has been once given to the sights, the rules to be applied by the Nos. 1 become reduced to the simple mechanical operations of 1, Levelling the sight; 2, of Aiming; and 3, of Firing; which will give accurate shooting whether the gun be on a perfectly level platform, in a ditch, or on the side of a hill, because the very fact of levelling the sight causes the gun to be fired from, as it were, a level platform.

This condition of things, therefore, gives to the No. 1 perfect command over the axis of the piece, which, with the service system of sighting, when the wheels are not on the level, he catches at in vain by mental calculations which are not applicable in practice. It also gives to the commander of artillery far greater control over his batteries, whose fire he can hurl at will with a constant unerring effect against an enemy, and, consequently, it makes him far less dependent on the intelligence of others for carrying out in action his own part of the programme to the best of his abilities, because it

most 2, are sufficient by the proposed method. The German battery would be annihilated during the interval of time which would elapse before the correct range was found.

transfers to himself the power over the shooting of his guns, which is now uncertain, inasmuch as it is in the hands of the Nos. 1, who have to make accurate calculations.

Now let us examine what causes of error in the service sights have been removed by the revolving sight. 1. Errors in shooting from *inclined sights* are dispensed with by placing the revolving sight into an upright position. 2. Errors due to "*wind*" and "*drift*" are corrected by the mechanical method of moving the deflection scale to one side until the notch of the backsight, the tip of the foresight, and point of impact of the shot are in line. 3. Errors from "*sun*" are dispensed with by covering the foresight with a tunnel, and by providing an eye-hole instead of the notch.

From the above we see that all the causes of error in shooting inherent in the service sights have been obviated by the revolving sight except one, viz., that one due to *not being able to see objects clearly at distances equal to the ranges of the gun.* To provide against this defect, I have added a telescope to the revolving sight, which, besides possessing other advantages, will enable the firer to see objects at the full ranges of the gun. This sight I designate the *Telescopic revolving sight.* It differs only in mechanical construction from the simple revolving sight just described. The principles on which it is constructed are similar and the rules applicable in the case of the revolving sight, for correcting the range and direction of the shot, are equally applicable in using the *Telescopic* revolving sight.

In this Telescopic sight we have, then, an instrument theoretically and practically fulfilling the conditions of a true sight for guns, which will enable the firer to utilize the best shooting qualities of the gun, and to produce those qualities at critical moments when called upon to do so, because the excellence of the shooting does not depend upon the coolness and intelligence of the firer for making mental calculations, but upon *mechanical adjustment*, in which there is very little to learn, and, consequently, very little to forget.

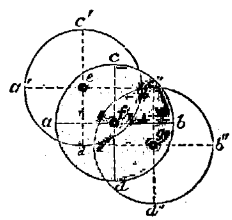
The Telescopic revolving sight, *see* Plate I. The Telescopic sight is merely a revolving sight, with the deflection scale enveloped in a telescope. The angle of elevation is given by depressing the telescope by means of the screw, E, through the required number of degrees read on a vertical arc. The screw, E, is a micrometer headed slow-motion screw, reading to two minutes. This micrometer arrangement dispenses with the difficulty of reading a vernier. Inside the telescope there are cross wires, by which the line of sight is taken. These cross wires are fixed to a sliding diaphragm, which can be displaced to either side for giving "right" or "left" deflection.

The telescope is supported by two supports, one of which is the vertical arc. These supports are attached to the axis of revolution of the sight, which I call the trunnions of the sight; a cross level is fixed at right angles to this axis to regulate the verticality of the sight. From this axis project on either side two projections, one for holding the levelling screw (W), the other for placing under a spring which is fixed to the bracket. The hemisphere at the end of the screw (D) fits into a cup on the underside of the bracket. When the cup is in its place, the sight can be levelled by turning the screw (W). The bracket which is rigidly fixed to any part of the gun contains two grooves cut parallel to the axis of the piece into which the trunnions of the sight are placed.

The introduction of Telescopic revolving sights, constructed on sound principles, gives one new ideas and a new interest in artillery fire, and develops an entirely new and simple system of "laying" guns. With the Telescopic revolving sight the error of the shot in direction is corrected in the same manner as in the case of the revolving sight, by traversing the cross wires (answering to the notch of the deflection scale) till they correspond with the point of impact. This process also corrects the error in *range*.

In order that the error in range may be rectified by the above method, the point of impact should be observed and corrected by a man looking through[1] another telescopic sight, from another gun alongside similarly adjusted for "elevation deflection," and aimed on the same mark as the one on the gun about to fire the trial shot.

Example.—Suppose a battery of six guns is required to silence in detail by salvoes, batteries of the enemy coming into position at a range of 3,000 yards:—The Nos. 1 of each gun must aim with the same "elevation" at the same gun of the enemy's batteries, and in order to check the accuracy of the estimated range, No. 1 of No. 1 gun only will fire, the remaining Nos. 1 must each look through their telescopes to observe the point of impact of the trial shot. (See diagram.)



Let *ab* and *cd* in the diagram represent the horizontal and vertical wires in the "fields" of the telescopes. 1. If the shot fall anywhere above *ab* as at *e*, the Nos. 1 will know that the shot has fallen long and to the left of the object aimed at, and that the intersection of the wires *ab* and *cd* is to be brought into the dotted position *a'b'* and *c'd'* covering *e*, first of all by moving the telescopes *vertically* by the screw (E) to correct the "elevation," and secondly the cross wires horizontally by screw (D) to correct the deflection. After this operation the above-mentioned screws, for elevation and deflection, (E) and (D) must on no account be touched, but the aim in every case must be readjusted on to the target or object to be hit, by means of the elevating screw of the gun and by a lateral movement of the

[1] This has hitherto been invariably successfully performed by running the gun up again and by using only one Telescopic sight.

trail. The corrected elevation and deflection registered on the "vertical arcs" and "deflection scales" of the other guns must be applied to the sight of the gun which has fired the first shot.

Then to obtain accurate fire, the Officers will only have to see to the carrying out by Nos. 1 of the simple mechanical rule of "Levelling "the sight" before "aiming" and "firing," and they will, consequently, be in a position to devote their time to the watching of the effect of the firing and to the manœuvring of their batteries, instead of making calculations which ought but cannot be made by the men. 2. If the shot fall below *ab* as at *g*, the shot will have fallen short and to the right of the mark, and the same rectification for range and direction as above described will be required, as shown by the position of the wires *a''b''* and *c''d''*. 3. If the shot fall at the intersection of *ab* and *cd* as at *f*, the shot will have hit the mark and no correction will be required to be made.

The power of being able without mental calculations to correct mechanically the error in range of a shot, in addition to the error in direction, gives great value to this system of sighting, and renders the instrument, in addition to all its other advantages of accuracy and simplicity, equivalent to a range-finder.

It is obvious that it is of no consequence whatever for the firer to know the exact number of yards that the shot has gone over or under the mark, provided he can adjust his sight, by mechanical means, so as to hit that mark. If the shot do not fall at the intersection of the cross wires in the "field" of the telescope, it suffices for him to know that he has missed the mark, and that he must direct the cross wires on the point of impact to correct his "line of sight."

By a simple arrangement the instrument could be used to find the range, and the resulting range could be applied to the "sights;" but it by no means follows that a gun fired with the proper elevation for the range thus obtained, will hit the mark with the same certainty as when the correct "elevation" and "deflection" has been obtained by the above described mechanical method, which takes into account simultaneously, without any mental calculations, all extraneous deflecting causes at the time of firing, whether they arise from the varying force of the wind, the inequality of the powder, or the inclination of the "sights" from uneven platform.

If the enemy's battery were on level ground, or on ground sloping away from the position of your gun, the application of the above method for correcting the error in range would be difficult; but, *as a matter of fact, batteries of artillery would necessarily be in commanding positions with ground sloping to their fronts*, therefore this method could be carried out in the field just as well as in coast batteries in elevated positions above the sea.

Now let us see how this revolving system of sighting has stood the test of a trial by those who would have to use it on service. The revolving sights have only been tried twice on service conditions by batteries of artillery, and in both cases, in my opinion, the result has been exceedingly satisfactory. The first trial was made with the revolving sight at Okehampton in August, 1879. One was fitted to a new 13-pr. gun of Major Stuart Nicholson's 13-pr. battery under trial. I was present at the trial.

Major Nicholson very kindly put the ten men who were to fire the competitive practice for prizes with it at my disposal for instruction. I gave them about thirty minutes' instruction, and asked Major Nicholson to allow these ten men each to fire one shot before commencing the competitive practice, to which he at once acceded.

The target was placed at 900 yards. The first man of the ten who were about to fire, adjusted the sight to the proper elevation and levelled it in the gun. The gun was fired, the point of impact was to the right. The next man, who had noted the point of impact, was directed to correct his line of sight mechanically by the prescribed method of moving the deflection scale laterally, till the notch of backsight and tip of foresight and point of impact were in line. This man then turned the gun on to the target, aimed with this corrected line of sight, levelled the sight and fired. The shot struck the target. Then each of the remaining eight men fired his shot in succession without altering the elevation or deflection, but taking care to level the sight before aiming, because the wheels were on very rough ground. The ten men were then taken over by an Officer of the battery, and they completed the whole of the competitive practice, consisting of four rounds each, without doing anything to the sight but levelling it.

The following are the results copied from Major Nicholson's paper in the "Royal Artillery Institute Proceedings":—

Target, 6′×6′. Range, 900 yards.

Bull's eyes	7
Direct hits	23
Ricochets	2
Misses	8
Total	40

(Gun-wheels were never in the same position.)

"One miss was due to projectile having jammed in the bore. The "remainder, with two exceptions, were due to very small errors right "or left. Their elevation was correct."

These results appear to me to be very satisfactory, and the sights were much appreciated by the non-commissioned officers and men of the battery.

From what I could gather from Major Nicholson on the ground, he was of opinion that the accuracy of the fire was very remarkable, and that for facility in teaching the men, for quickness in working, and for accuracy, this revolving system was infinitely superior to the present one, and that it should receive every encouragement. I will now read you the opinion of Major Nicholson's Lieutenant, who used the sight himself:—

Extracts from a letter of Lieutenant CAMPBELL, *Royal Horse Artillery*, to Captain SCOTT, *R.E.*

On the last day of our practice there, your sight was used on one of the guns of my division, and I personally superintended the "laying," and found that the men who successively acted as Nos. 1 at the gun were able to use the sight intelligently and accurately. The ground was *very* uneven, and rarely, if ever, was the level of the wheels the same for two successive rounds, so your system was thoroughly tried, and I have no hesitation in saying that it is (*where extreme accuracy of fire is desired, and rapidity is essential*) a most undoubted advantage to be able to arrange *mechanically* for the "deflection" to be given for a difference in level of the wheels, without calculation, and with a certainty of giving the required "deflection," in the RIGHT DIRECTION; for I have frequently found that, through *inadvertence*, a gunner, who can work out the necessary mathematical calculations *correctly*, will spoil the whole thing by putting the "deflection" in the wrong direction, thus *increasing* the error, instead of doing away with it.

Under similar conditions the gun can be laid with your sight much more rapidly and with much more certainty of accuracy than with the service sights.

I may mention that *seven* different men of the detachment took the part of No. 1 on the day in question, some of them gunners of very ordinary intelligence and with no *previous* knowledge of the use of your sight, and they seemed to understand it very readily, and to find it a great boon not to have to make any calculations about "level of wheels."

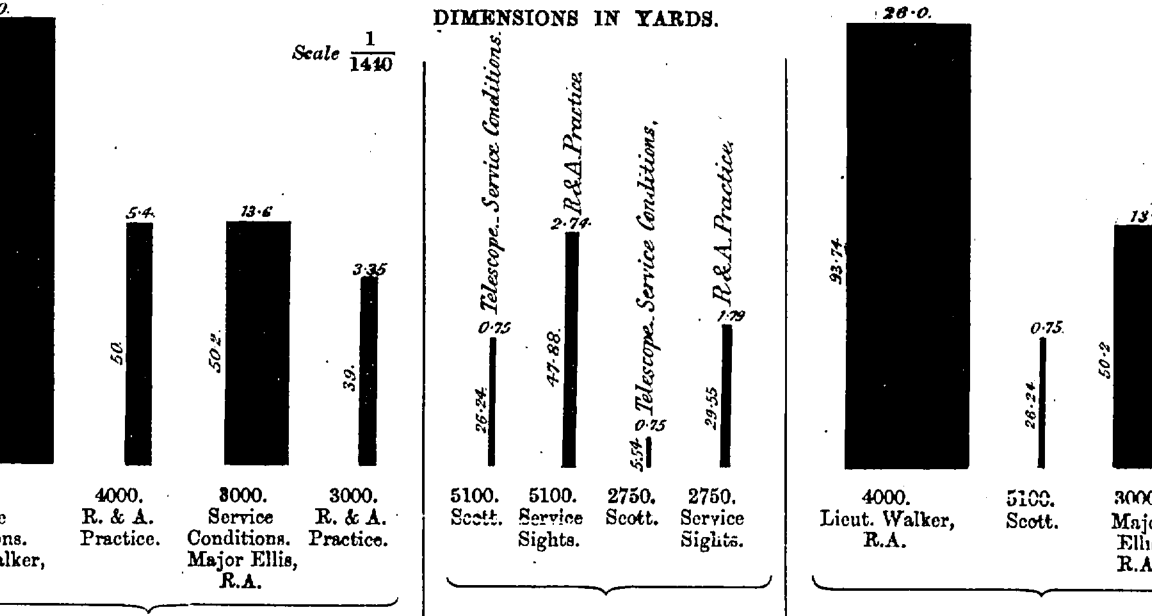
Personally I found your form of sight (fore and hind) more easy to "lay" with than with the sights issued to us with the 13-pr. gun. With the latter I found a great "blurr" on the hind-sight, when trying to "lay" accurately on an indistinct object, like a gun-pit; but I did not experience this with yours. Another advantage which I consider your sights to have over the service or experimental sights, which we have at present, is that (when firing at a fixed range, having once raised the sight to the required elevation) it is not necessary to touch the sliding bar again as long as the range is the same, because the sight is lifted intact from the socket before each round, and has merely to be dropped into its place again after firing, when it is at once ready to be "levelled" and "laid."

I tried your plan for correcting the error in direction due to deviation or other causes apart from the matter of "wheels," and I found that at the second shot I got the correct "line." The range in this case was over 3,000 yards.

As we only had your sight about three days I cannot claim to be able to point out *all* its merits or defects; but *I think if introduced into the Service, it will be welcomed by every one who wishes to see good shooting made by the "rank and file,"* who cannot be expected to be intelligent mathematicians.

The advantage of this Revolving System was particularly impressed upon my mind on one occasion when I was watching a battery of five guns firing at some gun-pits. The Officers were superintending the practice and supplying the Nos. 1 with the elevation and deflection they thought necessary for the range. Nineteen or twenty shots were fired. One gun I think hit the mark twice, but none of the others hit it at all. Now, if all the guns had been sighted with the revolving sight, the elevation and deflection of the gun which had hit the gun-pit could have been at once borrowed from that gun and applied to all the sights of the other guns, and the result would have been that they would all have hit the gun-pits.

This, of course, could not be done with the service sights, because the gun-wheels were resting on rough ground, and consequently all the sights were inclined at different angles of inclination—some to the right, others to the left; whereas, with the revolving system of sight-



...rison of Shooting with Service Sights on ... Conditions" with "Range and Accuracy" ... with Service Sights.

Comparison of Shooting on "Service Conditions" with Scott's Sights, and with R. and A. Practice with Service Sights.

Comparison of Shooting on ... Conditions" between Scott's an... Sights.

ing, all the guns would be fired from, as it were, a *level platform*, whatever might be the inequalities of the ground. By this circumstance the Officers can attend to their other duties, and can have the firing of their batteries carried out with certainty and regularity by salvoes, which plan of firing affords the following advantages: 1. *That the enemy's batteries can be annihilated before they have time to change their positions.* 2. *That owing to the dispersion of the smoke the view to the front will not be obstructed by the smoke of guns fired independently.* 3. *That the disturbance of the aim which might take place in guns fired one after the other from the concussion is obviated.* 4. *That the commander of the battery has greater command over his fire.* 5. *That it prevents independent, unaimed, and random fire.*

Since this trial, the revolving sight has been fitted to only one of the new 13-pr. breech-loaders for further experiment. The merits of this system of sighting would be far better appreciated if all the guns of a battery, instead of only one, were fitted with these sights, because then an opportunity of realizing the working of the system would be afforded; and, moreover, a comparison could be made of the annual practice of such a battery with that of previous years of other batteries sighted with the service sights.

The second trial was made in France with the *Telescopic* Revolving sight in July, 1880.

Tables I and II, pp. 119 and 120, show the results of the practice from which I have calculated the rectangles into which 50 per cent. of the shot would fall, and I have compared these—1st, with the "range and accuracy" rectangles of the 13-pr. in Table III; and, 2ndly, in Table V, Plate II, with the rectangles on service conditions made with the service sights and 16-pr. by Lieut. Walker, R.A., and by Major Ellis, R.A., at 4,000 and 3,000 yards respectively, by which it will be seen that R. and A. practice is at least three times better than practice on "service conditions."

Before examining these rectangles it is necessary to grasp thoroughly the difference between "range and accuracy" practice and practice on "service conditions."

Range and accuracy practice is to test the shooting powers of a gun. It is carried on in the following manner:—A calm day is selected, the charges are carefully mixed and weighed, the gun-wheels rest on a perfectly level platform, an expert aims the gun at a fixed mark which can be distinctly seen, and which serves as the point of aim for all the distances at which the gun may be fired. In this manner series of ten rounds are fired with varying degrees of elevation, which are given by the quadrant. The several groups of shots thus formed on the ground are then carefully measured and transferred to paper, from which the rectangles are calculated into which 50 per cent. of the shot would fall.

The rectangle on service conditions represents the shooting of the gun under very different conditions to those just described. An ordinary gunner lays the gun, the wind is blowing, the charges are not all carefully mixed and weighed, the gun-wheels are inclined at all sorts of angles, and mental calculations for correcting errors in shooting have to be made. Under these circumstances it is not surprising that shooting under "service conditions" must be vastly inferior to "range and accuracy" practice.

On comparing the shooting of Major Ellis and Lieutenant Walker on "service conditions" (which would be above the average shooting), with "Range and Accuracy practice," Table IV, Plate II, it is not exaggerating to assume that "Range and Accuracy practice" is 3 times better than practice on Service conditions."

On this supposition let us examine the various rectangles from the French practice for 5,100 yards and 2,750 yards, shown in the Tables I and II, and draw a comparison between them and the Range and Accuracy practice of the new 13-pr. muzzle-loader.

Taking from Table I the twelve shots which were fired with the same elevation and deflection, viz., 12° 30′ and 20′ respectively.

$$\frac{\text{The Scott rectangle with telescope}}{\text{13-pr. Range and Accuracy}}=\frac{13\times\cdot 37}{23\cdot 94\times 1\cdot 37}=\frac{1}{6\cdot 8}.$$

But the Scott rectangle is deduced from shooting which was really on *exaggerated* "Service conditions," and not on the perfect conditions of Range and Accuracy described above, because for several rounds the wheels were abnormally inclined to test the accuracy of the principle of the sight, and there was a strong wind. Hence the Scott rectangle on *service conditions* is 6·8 times better than the Range and Accuracy practice of the 13-pr., and since it has been proved by Table IV, Plate II, that Range and Accuracy practice is 3 times better than the ordinary shooting in the field, it is clear that

$$\frac{\text{Scott rectangle on Service conditions at 5,100 yards}}{\textit{Service sight R. and A. practice at 5,100 yards}\times 3}=\frac{1}{3\times 6\cdot 8}=\frac{1}{20\cdot 4}.$$

Again, in Table II, if six shots, with the same elevation of 5° 14′ for 2,750 yards, be taken, and the rectangle calculated,

$$\frac{\text{Scott rectangle}}{\text{Service sight Range and Accuracy practice}}=\frac{1\cdot 61\times\cdot 304}{14\cdot 775\times\cdot 895}=\frac{1}{27}.$$

But these shots were fired on service conditions, for the gun-wheels were inclined 10°, and the gun was aimed by different men. Therefore, if the same reasoning be applied as above,

$$\frac{\text{Scott rectangle on Service conditions}}{\text{Service sight Range and Accuracy practice}\times 3}=\frac{1}{27\times 3}=\frac{1}{81}.$$

In the French trial the Committee compared the rectangle calculated from eleven shots out of twelve (leaving out the first) with their range and accuracy practice for the 95-mm. gun, which makes

$$\frac{\text{Scott rectangle}}{\text{French rectangle Range and Accuracy practice}}=\frac{5\cdot 5\times\cdot 75}{24\cdot 2\times 3\cdot 16}=\frac{1}{17}.$$

But the Scott rectangle being on service conditions, the proportions should be $\frac{1}{3\times17}=\frac{1}{51}$.

Comparing the Scott rectangle of eleven shots with the 13-pr. "Range and Accuracy" practice,

$$\frac{\text{Scott rectangle at 2,750 yards}}{\text{Service sight Range and Accuracy rectangle}}=\frac{1}{12\cdot8},$$

but the Scott rectangle being on service conditions, the proportion should be $\frac{1}{3\times12\cdot8}=\frac{1}{38}$.

On examination of the tables, the Telescopic sight is found to be so true that 1′ more or less in elevation is rendered apparent by an increase or diminution in the range. Tables III and V, Plate II, show, by the size of the rectangles (which are all to the same scale, and which are calculated to contain 50 per cent. of the shots fired), very clearly the advantage in shooting possessed by the telescopic revolving sight over that by the service sights.

No matter in what way the Tables I and II are examined and treated, the only conclusion to be deduced is that much better shooting can be obtained by the use of a Telescopic Revolving Sight than by that of the ordinary service sights.

But there is one point which, to my mind, outweighs all the rest in importance, and which is not sufficiently taken into account by those who have to decide upon the value of this system of sighting, viz., the little training which is required to use these sights as compared with the amount of instruction to get over the intricacies of the service sights. This great improvement in shooting is obtainable by any man of the meanest intellect, provided he can take a correct aim, because all the mentally-calculated deflections necessary to be made for the Service Sights, by intelligent men, are entirely obviated by the *mechanical* adjustments of the Revolving Sight, the application of which can be learnt in the shortest time. It is urged by some that sights without telescopes, merely aided by the use of a binocular, are sufficient, but, as the aim has to be actually taken by sights without a telescope, the object which has been previously clearly seen by the binocular is lost to view again when the aim is taken. It is equivalent to expecting a man to see a mark *without* a telescope which can only be seen *with* a telescope.

The following are the conclusions and opinions of the French Committee who tried the Telescopic sights:—

1. That the instrument experimented with is an instrument of exact aim.
2. By its use the firer can aim accurately at distances equal to the range of the gun.
3. He can aim and fire at objects invisible to the naked eye.
4. He can always direct the cross wires on the same point of the mark, and consequently always take the same aim.
5. A shot having been fired, he can judge of its effect whilst aiming the following shot.

6. He has in no case to trouble himself with the inclination of the wheels, and consequently always fires as if the wheels were on a horizontal platform.

7. With a little practice, when once the angle of elevation and deflection shall have been given, no matter what man, will be able to aim in all weathers *more rapidly than with the service sight.*

The Committee consider, therefore, that it would be advisable to adopt this new system of sighting for the new guns.

That it would be expedient that all field guns should be fitted with a bracket necessary for the telescopic sight.

That two of these telescopic sights should be in the box of instruments, and that a certain number of non-commissioned officers should be instructed in their use, as they are in that of the range-finder.

The Committee in conclusion consider it their duty to lay stress on the splendid results which have been obtained, and to call special attention to the fact, that Scott's telescopic sight solves completely and practically the problem of a telescopic sight; and that its adoption by an artillery will give to that arm a very considerable advantage if it has to engage an artillery unprovided with an analogous system.

Persons who are unacquainted with the principle of these revolving sights imagine that I consider the telescope the chief advantage of these sights, whereas the telescope is a minor detail as compared with the principles mechanically embodied in these sights, which permit of the corrections for errors in range and direction being made by mechanical adjustment, instead of, as heretofore, by calculations. A telescope is needed when the object cannot be clearly seen by the naked eye.

There are, however, other and very important advantages in the telescope:—

1. *The "line of sight," being contained in the telescope, needs no fore-sight;* 2. *The cross wires ensure the same aim being taken by every man, which consequently eliminates the variable personal error of each No. 1;* 3. *A short-sighted man can see to aim as well as a long-sighted man.*

No. 1 advantage allows of the telescope being fitted to any part of the gun most convenient. For instance, on the breech, trunnion, or even muzzle of the gun. This latter position for a telescope, if covered by a shield, would allow of a direct aim being taken over a parapet, at an object, with very little danger to No. 1.

Under all circumstances, the most accurate and only trustworthy method of laying a gun is by a direct line of sight on the object. This can be well done by the aid of shields and telescopic sights.

The telescopic sight would be advantageously employed if fitted to the muzzle of the gun, together with a shield to cover the opening, for firing out of casemates or out of narrow openings, such as would be required for aiming a gun through an armoured gun carriage, through the front of which the muzzle only of the gun would show, and which would also recoil with the gun. Such an arrangement appears to me to be more simple and practical than the overbank carriage.

The telescope is, also, an absolute necessity for firing at high angles where the tangent sights become exceedingly long and inaccurate, such as in howitzers.

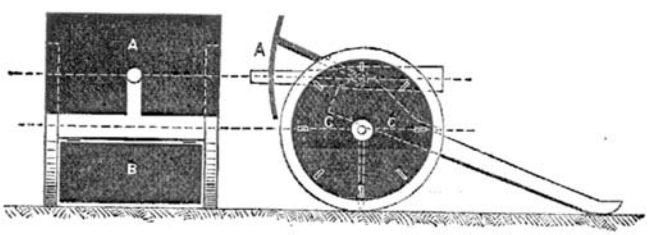
There are many useful applications of the telescopic sight which I have not time to mention, and probably many more, of which I am ignorant, but which, no doubt, would be developed by others, who would take an intelligent interest in its use, and who had opportunities afforded them, which I have not, of studying it by actual practice.

I think it would prove invaluable as a scientific instrument to an experimental Committee, because it affords, by its great accuracy, the means of making researches into the mysteries of gunnery, by which one could assign, with absolute certainty, to the whole deviation of a shot the proper share of each of the causes which may have deflected it, or caused it to fall long or short. These causes are: 1. *Incorrect aim;* 2. *Drift;* 3. *Inclination of the wheels;* 4. *Wind;* 5. *Inequality of the powder.*

We have lately heard a good deal about long-range fire with rifles, but I think that the fire of a Nordenfeldt gun, aimed with a telescopic sight, would prove far more effective at long ranges than that of several rifles, each aimed, or rather not aimed at all, by different men. By a simple arrangement the telescopic sight can be used as a range-finder. It can also be used for firing at night, and for judging and regulating the bursting of fuzes above plane.

I have shown how artillery fire may be improved by the use of proper sights; but there are other means of not only improving the fire, but the fighting power of the gun, viz., *by the introduction of shields.* These were proposed by Colonel C. B. Brackenbury, R.A., but I believe not as a part of the gun. Major Stuart Nicholson, R.H.A., has lately made several suggestions on this subject; one was the very practical suggestion of plating the lids of the boxes on the axletree of the gun carriage, and of utilizing them as shields. Captain Walford, R.A., has also suggested the most excellent idea of steel plating instead of spokes for the wheels. I myself suggest shields as shown in the sketch, or on the principle of the Japanese umbrella, the gun acting as the stick. The former arrangement presupposes the steel plate

Shields for Field Guns. Scale $\frac{1}{72}$.



A. Shield $\frac{2}{16}''$ thick $6' \times 3' = 90$lbs. }
B. Shield $\frac{2}{16}''$ „ $5' \times 2' = 50$lbs. } $=140$ lbs.
C.C. Steel plate centre instead of spokes for wheels.

instead of spokes for the wheels, and consists of two shields $\frac{2}{16}''$ thick, weighing 5 to 6 lbs. per square foot. The upper one $6' \times 1\frac{1}{2}'$ rests on the gun just in front of the wheels which form a backing. It is attached to the trunnions of the gun by two arms, and perforated with a hole through which the muzzle passes. The lower one is a steel plate 5'×2' hinged to the underneath of the axletree. The two together complete would not weigh more than $1\frac{1}{2}$ cwt., which is the weigl which can be carried by one mule. This extra weight would be considered perhaps at first by artillerists sufficient reason for condemning them at once as affecting too much the mobility of their guns, but when we consider that the selected position for artillery would not be constantly changed, that a man would take infinitely better aim behind a shield, and that guns could be fought at closer ranges with comparative safety from rifle bullets, it behoves us to give the subject serious consideration.[1]

From what has been said, it has been proved in my humble opinion, and others will come to the same conclusion if they will take the trouble to master the gist of the proposed system, that any gun on "service conditions" with these Telescopic and Revolving Sights will shoot, *without any calculations* whatever, at short ranges two and a half times better, and at long ranges six or seven times better, than with the service sights *with calculations.* Hence, these improvements when applied to a gun, are equivalent to the production of a gun three times more accurate than any gun of the present day for a maximum cost of about 6*l.* per gun, which, when compared with the price of a gun and of a single shot, is very small indeed.

Few persons realize what the cost of a shot is. They have an idea that it ends with its manufacturing price in the arsenal. It only begins then. There is first to be considered the price of the powder, then that of the shot, then the cost of ammunition wagons, of horses, of men necessary for transporting gun, powder, and shot to the place of action. To all this must also be added a certain proportion of the cost of the gun itself. Thus, if a gun has cost 10,000*l.*, and if 1,000 rounds can be fired from it before becoming unserviceable, each round would cost $£\frac{10000}{1000}=£10$ worth of the life of the piece.

Even if the proposed sights were to make the gun shoot *without* calculations only as well as the present sights *with* calculations, the very fact of doing away with those unpractical calculations ought to suffice for the introduction of such a system. The present system of sighting is as much behind the revolving system as the smooth-bore is behind the rifle. It neither does justice to the rifled gun nor to the firer. Practically speaking, the present sights are in about the same state as when they were invented by Robins 120 years ago. Perhaps they were quite good enough, because the old smooth-bore guns of that time were extremely imperfect in their shooting, whilst their longest effective ranges were what we should now consider almost close quarters.

A gun sighted with a system of sighting which will only allow of its being fired with accuracy when the wheels are resting on a

[1] Since writing these remarks, the necessity for improved training in shooting and for shields has been painfully illustrated by our late experiences with the Boers at the Battle of Ingogo, where the guns were whitened with bullets and nearly all the gunners killed.

perfectly level platform—a case which rarely occurs in practice—is like a ship without a rudder, an imperfect machine!

If then a system of sighting can be devised which will give the gunner without any calculations complete control over the axis of his gun under all conditions instead of only when the wheels are on the level as at present, and then only to a limited extent; and if he can be taught by this System of Sighting to become a good shot with *only the small regulation allowance of ammunition*, it certainly ought to be a great boon to the Gunner, and a *great saving too of expense to the State*. The proposed Telescopic Revolving and simple Revolving sights fulfil all these requirements, because the use of the telescope with cross wires removes all difficulty of aiming, and the corrections for unequal height of wheels, and for wind, can be effected by the simple turn of a screw *without any calculations*, and, being effected, remain perfectly accurate till a change in the force and direction of the wind occurs.

It has been calculated that for every man slain in the Franco-Prussian war two tons of lead and iron were expended; but the percentage of killed by the iron which represents artillery fire was very small as compared with that by the lead. Captain Boguslawski gives the number of men slain at Gravelotte by artillery fire as low as 6 per cent. The only conclusion to be drawn from this is that the artillery fire must have been very wild and bad. This result is certainly not due to any fault in the gun, which is turned out to $\frac{1}{1000}$ of an inch in accuracy of manufacture, but it is obviously attributable to *want of proper training in the men and to faulty sights*.

Depend upon it, gentlemen, that *with the introduction* (1) *of a properly established system of training in gunnery practice for every contingency of warfare*, (2) *of a practically and theoretically correct system of sighting*, (3) *of telescopic sights*, (4) *of breech-loaders*, (5) *of a good retarded action percusso-time fuze for shrapnel, which would burst the shell on the upward bound immediately after graze*, (6) *of shields and armoured gun carriages*, artillery fire will be as destructive in warfare as it is shown it can be in peace time by "Range and "Accuracy" Practice. There will then be developed a new and intelligent interest in the science of gunnery, and a very important era in the future tactics of our artillery.

In conclusion, gentlemen, I beg to tender my best thanks to the Council of this Institution for allowing me to bring this very important subject before your notice, to Admiral Sir Frederick Nicholson, for the honour he has conferred upon me by presiding, and to the distinguished audience for their patience in listening to the enunciation of a system of sighting which I trust may not only prove a boon to the Gunner but a benefit to the Service and country. It is no use waiting for some foreign Power to give us the lead in these improvements. They are patent to everyone and we ought to have them at once. Let us have the courage of our own English opinions. We have a comparatively small Army, and it should be the best procurable at the price.

Objections.

The Delicacy of the Telescopic Sight.

With all due deference to the opinions of the gentlemen who have made objections to the use of a telescopic sight, I beg to point out that delicacy is not a logical objection to urge against the employment of a telescopic sight, because all telescopes must be delicate on account of the glass. The glass being the weakest part of the telescopic sight is therefore in reality its strongest part, for if the glass be broken the telescope will be rendered useless. Theoretically it is unnecessary therefore to make any part of the telescopic sight any stronger than the glass.

The reasonable question to be answered is, whether a telescopic sight be necessary; if it be so, then you must take care of it and be prepared to put up with delicacy of the glass, seeing that no telescope can be a telescope without a glass.

How is the sight to be carried? This is a question which I have been frequently asked. A man who asks such a question seriously cannot realize the fact that accurate fire is the *raison d'être* of artillery, and that without good sights, which are the vital parts of the gun, you cannot extract the shooting powers of that gun. A gun without a sight is like a fine handsome fellow without any brains.

One might just as well inquire how and where the key of a clock is to be carried, or where the Rammer or any other necessary store of the gun is to be carried. *If the telescopic sight be worth having it is worth carrying.*

The Advantages of the Telescopic Sights.

1. That the firer can see to aim at distances equal to the range of the gun.

2. That he can see and seek out objects to fire at not discernible to the naked eye.

3. That he can always lay the "cross wires" on the same spot with absolute certainty, thereby dispensing with the errors incident to aiming with the ordinary sights.

4. That he can detect the position of the point of impact of the shot in the field of the telescope and know whether the shot has hit by the appearance of the object.

5. That a *field gun* on the natural surface of the ground will be able to shoot at short ranges without having to make any calculations at all, at least three times, and at long ranges ten times, better with the telescopic sight than with the service sights, because the firer in action is unable to make the calculations for inclined wheels necessary for accurate shooting with the service sights.

6. Taking a correct aim is independent of the human eye, and of any practice on the part of the firer.

7. That firing can be carried on almost as accurately at *night* as it is in the day time, by directing the "cross wires" of the telescope on a light fixed at the proper elevation and in the proper direction,

because the light is reflected on the "cross wires" which allows of a "line of sight" being taken. This operation could be facilitated by having iron rails fixed on the platform as a guide for the trail to run between.

8. That it can be used to find the range.

Advantages of both the Telescopic and Revolving Sights.

1. That the firer has that complete command over the axis of the piece under all conditions which he has with the present sights only when the wheels rest on a perfectly solid and level platform.

2. That all calculations are eliminated, thereby enabling any uneducated gunner to learn to shoot accurately, provided he has got good eyesight, without the expenditure of ammunition or special training.

3. That the effective power of the gun in action will not depend upon the life of No. 1 of the gun detachment, because every gunner can learn to use these sights.

4. That the instruction to be imparted to the men will be much simplified.

5. That the destructive power of artillery will be enormously increased.

6. That a maximum effect will be produced by the expenditure of less ammunition than hitherto, and therefore the necessary amount of transport will be reduced to a minimum.

7. That a level platform not being required, the artilleryman will be no longer in the anomalous position of being dependent upon the work of the engineer for accuracy of fire, and considerable expense and trouble will be saved in permanent fortification.

8. That all calculations are eliminated by *mechanical arrangements* which *must* be far less liable to error than when left to the judgment of the firer.

9. That the manipulation of the instrument can be learnt by any man of the smallest intelligence.

10. When once the true elevation and deflection have been found, they are not disturbed, and consequently there is no chance of any error being made from the No. 1 having to set the sight each round; because the revolving sights are lifted out of the socket or grooves intact before firing.

TABLE I.

120 mm. gun placed on a horizontal platform. Wheels abnormally inclined by baulks. Charge, 7·5 lbs. Range, 5,100 yards. Object, a powder magazine forming a mass 4 metres square, with a target 3 feet broad on the top to aim at. 1 metre = 39 inches nearly.

It will be observed that the first shot fired was 30 metres long and 6 metres to the right. The French Officer in this case corrected the error in range and direction by Captain Scott's method himself, and the next shot fell in the required direction.

State of atmosphere and wind.	Elevation.		Deflection.	Short.	Long.	Right.	Left.	
	°	′	′	Metres.	Metres.	Metres.	Metres.	
	12	50	30	..	30	6	..	
Fine weather.	12	30	20	15	0	0	0	
Little wind.	12	30	20	0	0	0	0	struck mark.
Scott's sight.	12	30	20	..	30	0	0	
	12	30	20	5	..	0	0	
	12	30	20	..	5	0	1	
	12	30	20	20	..	0	0	
	12	30	20	..	10	0	0	
Clear, dry.	12	30	20	..	5	0	0	
Strong wind.	12	30	20	40	..	0	2	
Scott's sight.	12	30	20	..	10	0	0	
	12	30	20	20	..	0	0	
	12	30	20	..	5	0	0	

TABLE II.

Range, 2,750 yards. 95 mm. field gun.

Number of shots.	Elevation.		Deflection.	Short.	Long.	Right.	Left.	
	°	′	′	Metres.	Metres.	Metres.	Metres.	
1	5	5	8	40	..	..	8	Target knocked down.
2	5	14	38	0	0	0	0	
3	5	14	38	0	0	1	0	
4	5	14	38	1	0	0	0	Shell hole.
5	5	16	38	0	5	0	0	
6	5	14	38	0	5	0·5	0	
7	5	12	38	5	0	1	0	
8	5	12	38	1	0	0·5	0	
9	5	12	39	1	0	1	0	
10	5	14	38	0·5	0	0	0	
11	5	14	39	4	0	0	0	
12	5	16	39	0	8	1	0	

On this occasion the mark was a target 1·8 metres high, and 1 metre broad. The first shot having been fired with the angle of elevation and deflection from the tables, the cross wires of the Telescopic Sight were aimed on the point of impact of this first shot, by moving the axis of the telescope (horizontally and vertically) by means of the screws of the sight, and the corrected "elevation" and "deflection" thus obtained, were employed to aim the following shot, *which cut the target in half.*

In the course of the firing one wheel was placed in a hole, so that the angle of inclination of the wheels should be about 10°. The shots thus fired, which were 5th, 6th, 8th, and 10th, gave exactly the same result. The piece was aimed by different members of the Committee.

The alterations in the angles of elevation were made to test the sensitiveness of sight for aiming purposes. For instance, No. 4 shot with 5° 14′ was 1 metre short, No. 5 shot with 5° 16′ was 5 metres long.

Major Ellis' Table of Shooting with Service Sights at 3,000 *yards with* 16 *pr.*

Round.	Elevation.	Deflection.	Inclination of wheels.	Direction of shot in yds.		Remarks.
				Left.	Right.	
1	6° 10′ throughout.	5′ left.	From 1 to 10 degrees.	9·8		It was intended to give 32′ deflection for No. 5 round.
2		5 „		9·8		
3		0 „		1·6		
4		0 „		4·4		
5		12 „			26·0	
6		32 „			9·0	
7		32 „		2·2		aimed off target.
8		32 „			2·4	
9		32 „		13·0		
10		20 „		7·8		

Captain ANSTRUTHER, R.A.: Captain Scott has taken it as the fundamental principle of his sight, that the line of sight is always parallel to the axis of rotation, no matter how much the gun is turned round. I do not quite see how that is, the foresight being a fixed point, and the sight being movable.

Captain SCOTT: The axis of revolution and the tip of the foresight are fixed points. The line AB is parallel to CD, therefore when it is turned round, the line AB must remain exactly in the same position as it was before, becauseit is the same line.

Captain LONG, R.N.: I am afraid that I am the only representative of my branch of the Service present here to-night; but I am sure, however, that it is not from any lack of interest that they feel in this question. There are many naval Officers who will be very much obliged to Captain Scott for having taken the trouble to come here and explain his sight to us. It appears to me to be a most ingenious invention, and has been very ably explained. I do not quite understand whether the sight remains on the gun when it is fired.

Captain SCOTT: No, you take it off. You could not leave a telescope sight on the gun; you could leave a revolving sight on the gun, but I see no advantage in leaving it on, because when the gun was fired, the concussion would alter the elevation. In the Service they generally put the sights down, and each time before the gunner aims he has to re-set the elevation. Now, supposing that man were shot, the man who came after him might have forgotten what the elevation was; but if you have the sight permanently fixed, so that the man has nothing to do except to drop it into the socket of the gun, and level it, he has nothing to forget, and you can be perfectly assured that if he only aims straight, the shot will go in the right direction every time. The simple revolving sight could be left on, but I do not see any advantage in leaving it on. The French take their sights out, but it is only a matter of habit after all.

Captain LONG: Captain Scott mentioned the auxiliary barrel for getting practice, and as that seems to me a very important point, I wish to ask if he is aware of any instance of its use. Of course, anything which involves a spirit level can be of no use at sea, but it might be of use in practice on shore. I am particularly anxious to ask what is now considered the effective range of siege guns on shore. I should also like to know what the cost of the sight is; it looks rather an elaborate piece of mechanism, and the question of expense always has some weight in the adoption of these things. Captain Scott did not speak about the Navy, but he mentioned that *ninety shots per annum were considered necessary to keep an infantry soldier in* practice. In the Navy, our captains of guns, who, of course, are supposed to be the best shots, only fire eight shots per annum with their own guns. They have a great deal of theory, but uncommonly little practice. Then, with reference to this, we must not forget what Captain Colomb has often said in this theatre, that 10 per cent. are all the shots that are likely to strike the mark in a naval action with the vessels in constant motion, and I think that is borne out pretty well by practice so far as there has been any practice.

Captain ANSTRUTHER: Captain Scott said nothing about rapidity of firing, whether he could fire the same number of rounds using the revolving sight. In the German batteries, they consider ten to twelve rounds for a battery per minute about the ordinary thing on service, and eight rounds for slow firing.

Captain SCOTT in reply said: With regard to the effective range of guns on shore, I suppose that is limited pretty considerably by the view, and by the accuracy of the gun. I should think an artillery Officer could tell you better about that. I do not know much about it myself. The cost of one of these instruments, including bracket, sight, and box, is 11*l*., but of course, the maker gets a large profit out of that. I suppose you could make the sight itself for 3*l*. or 4*l*., and I do not think that this price is a very material consideration when you come to think of the cost of a shot from a heavy gun. In the first place, every shot that is fired takes out a certain amount of the life of the gun, and supposing a gun will last for 1,000 rounds and cost 10,000*l*., that is, 10*l*. for each round that is fired, besides the expense of the shot and ammunition, therefore I do not think 11*l*. can be taken into any consideration, when a shot costs so much; in fact, it is nothing compared to the price of the shot. The revolving sight saves a great deal of ammunition, and if you get more effect with it than with other sights, it pays in accuracy alone. With regard to rapidity of firing, the French report states that the rapidity of firing is greater with my sights than with the service sights. When asked whether I can fire quickly with the telescopic sight, I reply that it depends on the traversing arrangements of the gun. If you have a gun with the Armstrong movement, you can "lay" it very much more quickly with the telescopic sight. The reason that you think that you can "lay" it more quickly with the ordinary sight is, that you do not see where you are out. The German batteries fire ten or twelve shots per minute; that sounds very well, but there is no advantage in firing shot away at random. It would be much better to fire two straight ones than ten or twelve bad ones. As to firing eight shots a minute, that may be possible, but I doubt very much whether you would get really accurate fire at long ranges. You might at short, because it does not matter very much; the trajectory is low; but at long ranges, you would find you could not fire eight shots very accurately. With regard to the auxiliary barrel, I merely suggested it because drill without practice is absolutely useless. I take great interest in the matter. I was Instructor of Musketry for some years, and I know very well from experience, if you teach men drill it is not the slightest use unless you give them practice; they won't believe a word you say unless you show it in practice. The reason that I propose a tube inside the barrel of the gun is, *that though of course a rifle at the side of it could* be fired, yet that would not assist the gunner in manipulating the gun. The object of having the small barrel in the gun is to put them through their drill just as in ordinary firing, and I think if you give them small ammunition it certainly would impress the errors of shooting on the men.

The CHAIRMAN: You will, no doubt, all agree with me that Captain Scott deserves our best thanks for bringing before us this elaborate and interesting paper. We must all feel some regret that he is able to read a very minute, detailed, and favourable report from the Committee of Officers in France, and that he is only able to give very short extracts from the unofficial reports of Officers in England. I am not aware whether the sight has received the same amount of trial in this country as it has abroad, but I think it is manifest that it is fully deserving of such a trial, in order that its merits may be fully tested. It only remains for me to thank Captain Scott, in your name, for his very interesting lecture.