Evening Meeting.

April 30, 1860.

Colonel the Hon. JAMES LINDSAY, M.P., in the Chair.

NAMES of MEMBERS who have joined the INSTITUTION since April 16th.

Nott, A. H., Capt. Indian Navy
Miller, W. V., Paymaster Royal Navy
Hamilton, Sir E. A. Bart., Lieut. Cold. Gds.
Chelmsford, Lord, late Royal Navy
Blyth, W. D'Urban, Capt. 14th Light Drags.
Campbell, R. M., Capt. Roy. Elthorne L. I. Mil.

ON A NEW PRINCIPLE FOR THE PROTECTION OF RIFLEMEN.

By Francis Galton, Esq., F.R.S. &c.

A and B (fig. 1) are two combatants, armed with similar rifles or muskets, and firing at one another, over parapets not less than 100 yards apart. I propose to show that a screen may be interposed by one of them, A, that shall not affect the view which either party has of the other; that shall in no way prejudice A's power of hitting B; but which shall make it wholly impossible for B to hit A (by direct fire).

It is well known that the course of a projectile does not lie in a symmetrical curve, but that its *descent* is more rapid than its *ascent;* in fact, at average ranges, in the case of the Enfield rifle, it is nearly one-half more rapid; and in the case of a common musket ball, the ratio is still larger. Consequently, the trajectories of A's and B's shots, fired at the exaggerated elevation represented in fig. 1, and having a range A B, would follow pretty nearly the curves there represented; whereby it is clear, that a ball-proof bridge, W, would have the effect asserted to be possible. A's bullet would pass out under the bridge, but B's bullet would strike against the bridge.

In short, I wish to point out the advantage of firing at an enemy under horizontal bridges, placed some yards in advance.

We will proceed by examining into the precise facts of the case—into the actual angles of ascent and of descent of the Enfield bullets, at different ranges, and will thence deduce the precise amount of effective cover which the arrangement I propose might be made to afford.

I have compared with care such data as I could obtain upon the trajectory of the Enfield rifle, and believe the following tables will be found substantially correct.

In fig. 1—

A *h* B is the line of sight between A and B.

A *b* is the first part of the course of A's bullet, towards B.

a A is the last part of the course of B's bullet, towards A.

b d is the last part of the course of a bullet from B, so fired as just to skim the under surface of W.

Then no bullet fired by B, which passes under W, can possibly hit K higher than *d*.

In cases such as those with which we have to deal, A *a*, *b* A, and *b d*, may all be considered as straight lines, and not as parts of curves; and *a b* may be considered as equal to the distance between *d* and the top of the parapet K.

In computing the following table, A *h* has been taken = 1000 inches, that is, about 28 yards.

Yards Range.	Angle of Ascent.	Angle of Descent.	A *h* = 1000 inches = about 28 yards.		
			b h, inches.	*a h*, inches.	*a b*, inches.
0	0° 0′	0° 0′	0·0	0·0	0·0
100	0 12	0 22	3·5	6·4	2·9
200	0 24	0 42	7·0	12·4	5·4
300	0 38	1 7	11·0	19·4	8·4
400	0 54	1 33	15·7	27·6	11·9
500	1 13	2 8	21·2	37·4	16·2
600	1 32	2 41	26·8	47·5	20·7
700	1 55	3 25	33·4	59·0	25·6
800	2 22	4 10	41·3	73·0	31·7

It is upon the existence and the amount of *a b* that the protection, which W can afford, depends. I will now explain what appears to me as the simplest method by which a rifleman may avail himself of it.

I trust it will be distinctly understood that I do not venture to propose any particular description of shield; but that I confine myself to enforcing a principle, leaving its application to others. I am the more inclined to do so, as persons better informed than myself have suggested that extemporaneous contrivances would be, probably, the most feasible. A man crouching on the ground might fire below a gabion, or some equivalent for a gabion, laid crosswise upon two others and placed twenty or thirty yards in advance of him. There are cases where he might avail himself of the cover of actual bridges, or where, when sheltered in a building, he could stand far away from one of the windows, and so select his position that his bullet should skim below its topmost edge. Yet, while I do not pretend to advocate any regularly constructed piece of mechanism, I feel it will enable me to convey my meaning more precisely if I describe, as I will now do, some one arrangement that would undoubtedly give protec-

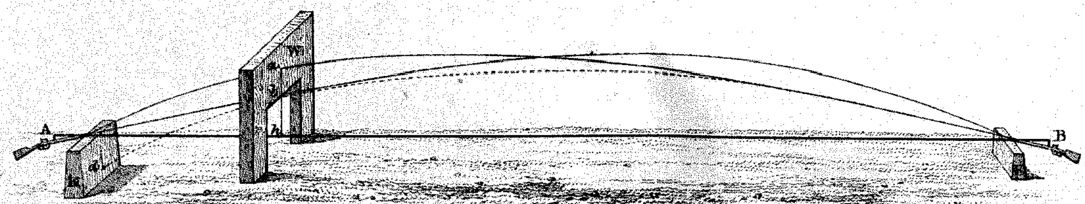

Fig. 1.

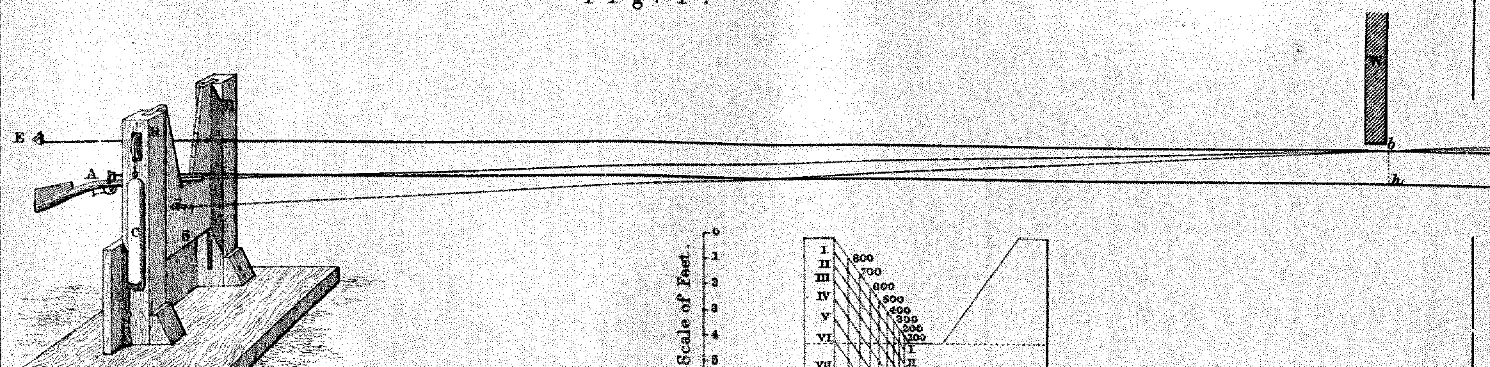

Fig. 3.

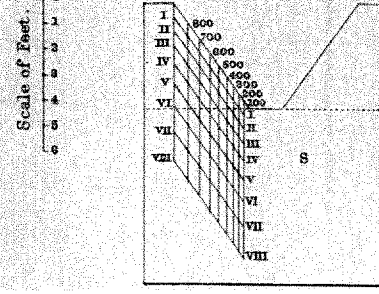

Fig. 2.

tion, and would also be well calculated for purposes of experiment on the truth of my figures.*

Figs. 2 and 3 represent a solid wooden "sash," S (like a window-sash), covered in front with wrought-iron plates of not less than one-eighth of an inch in thickness. It slides up and down between two supports, R, R, and is balanced by counterpoises, (one of which, C, is seen in fig. 3,) precisely as a common window-sash. This machine is placed 28 yards behind W, and the rifleman, A, stations himself behind the sash. He is supposed to fire, resting his weapon upon S, at the level of the dotted line (fig. 2), and the machine takes the part of K in fig. 1. The figures 800, 700, &c. standing for yards, will be observed upon the sloping edge of S (fig. 2). They are written *outside* of the sash, because the smallness of the figure made it impossible to insert them legibly upon it.

The object of them is to instruct A as to the elevation he may give to his sash, without obstruction to the egress of his own bullet, under W. The heights of the points to which these figures refer, above the dotted line in fig. 2, are taken from the entries in column *b h*, corresponding to 800, 700, &c. yards' range.

We will suppose that A wishes to fire at B with the sight of his rifle adjusted to 550 yards. He will elevate his sash until the line of sight that joins B and the under edge of W shall cut the sloping edge of the sash, half-way between the divisions 500 and 600.

But, as on the one hand a much lower elevation of the sash than this would suffice for A's security, so, on the other hand, if this extreme elevation of 550 be adopted, A will be secure, not only against B's fire, but also against that of as many other riflemen as the nature of the "bridge" principle permits. The limits of A's security are shown by the oblique lines I I, II II, &c. (fig. 2). They are all drawn parallel to the sloping edge of S and at *vertical* distances below it, corresponding to the entries in column *a h*. They are to be used as follows:—Suppose the sash has been elevated to 500; then B's bullet, fired from 500 yards and skimming the under edge of W, will hit the sash *level* with the point where the oblique line V V cuts the vertical line drawn downwards from 500. It will be seen, on reference to fig. 2, that this level is considerably below the horizontal dotted line (which is the limit of A's security). Similarly, the intersection of IV IV with the same vertical line gives a safe level; in other words, a rifleman at 400 yards cannot hit A when the sash of the latter is adjusted to 500 yards. At III III A's danger has commenced: riflemen at 300 yards, and on the same plane as A and B, can hit him.

There is still another case. Suppose A has made his adjustment for firing at B, when he observes a rifleman, C, on a different plane to that on which B and himself are standing: what is his security against C's fire? In answer to this, he has simply to consult the oblique lines, on precisely the same principle as that already explained. He must ascertain the point at which a line of sight, passing from C and skimming the under edge of W, will cut the sloping edge of his sash. Then, if a ver-

* I should be glad to learn whether a bullet suffers deflection from passing *very* near to an obstacle, like W; and, if so, at what distance from the obstacle its influence is felt.—F. G.

tical line, drawn downwards from that point, cuts the oblique line corresponding to the distance between C and himself *below* the dotted line, he is safe; otherwise, he is not.

Strictly speaking, in protracting these various measurements on fig. 2, allowance would have to be made for the diameter of the bullet.

If the reader will take the pains to fix a piece of paper, ruled like fig. 2, but drawn to a natural scale, against the upper sash of one of his own windows, and experimentalize on taking sights, he will find the practical application of the figure to be exceedingly simple, far more so than it would, probably, appear from the above tedious description.

Protection may be obtained at varying ranges, not only by adjusting the elevation of a sash, but equally well by adjusting that of the bridge, the sash remaining stationary; or by varying the horizontal distance between the sash and the bridge. I do not, as I have already said, propose to enter into practical illustrations of how these manœuvres may be conveniently effected; my object is simply to indicate a principle.

The way in which I have thus far put the case, does not wholly exhaust the merits of the "bridge" principle, especially when firing at short distances. I have hitherto proceeded on the supposition that A's rifle is aimed directly at B's rifle, and this would be pretty nearly the case if B were crouching in a rifle-pit or kneeling behind an embankment, exposing little more than his head to the fire of A. But if B be a soldier in the open field, that part of his person which is below the level of his rifle, when laid to his shoulder, exposes fully twelve times as large an area to the fire of A, as that part which is above it. Supposing B to kneel, the proportion will be about as 9 to 1. Consequently A need not aim at B's rifle at all. Especially at close quarters, he may elevate his sash so high as to prevent him from even seeing B's rifle, and may direct his fire at the level of B's belt, or even lower, while B would be wholly unable to see any part of A, much less to reach him with the direct fire of his bullets.

The principle of the "bridge" is just as true for cannon as for rifles; but it is another question, which I understand must be answered negatively, whether it would be possible, in practice, to construct and use such massive screens as would be required to withstand the battery of artillery.

Lastly, this principle is likely to be of greater relative advantage to us than to others, because our soldiers are the best armed of any nation; therefore their bullets have the flatter trajectories, and the value of $a\ b$ is consequently increased to their advantage and decreased to the disadvantage of their opponents. If the assailants' bullets had flatter trajectories than our own, $a\ b$ would be decreased, and might be reduced to 0, or even to a negative quantity, in which cases the bridge would be of no protection at all.