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LECTURE.

Friday, 24th June, 1870.

MAJOR-GENERAL D. RUSSELL, C.B., in the Chair.

SHELTER TRENCHES, OR TEMPORARY COVER FOR TROOPS IN POSITION.

By Colonel GERALD GRAHAM, V.C., C.B., R.E.

SHELTER-TRENCHES (*tranchées-abris*) may be considered a rapid application of field fortification for temporary purposes. They may be defined as having rather the character of offensive than of defensive fortification, resembling in their functions more the besiegers' parallels, or "places of arms" than intrenchments for the defence of a position, but they must always be considered as supplementary to natural cover and not as a substitute for it. In fact, as the title of this paper indicates, the primary object of "shelter trenches" is to obtain cover for troops in a given position, without interfering with their advance when required. Yet shelter-trenches may be combined with more purely defensive works, as when occupying the intervals between detached works, or portions of them may be converted into intrenchments, therefore they cannot be dissociated from field fortification, in fact they come under the general heading of temporary field fortifications.

Field fortification is perhaps the oldest art in existence, an art probably coeval with the history of man—that is with the history of war, and indeed our oldest records bear witness to its antiquity, whether graven on the granite of Egypt, or mirrored in the customs of contemporary savage nations. What changes have taken place since the Assyrian king "cast a bank against the fenced cities of Judah,"* and yet even now a general of an army, equipped and furnished with the latest results of science would, like Sennacherib, "cast a bank" against a modern fortress.

Fortification may, for our purpose, be sufficiently accurately defined as the art of protecting combatants while preserving their fighting powers, and thus, by lessening their adversaries' capacity to inflict injury, it strengthens, or fortifies, the side that employs it. Being

* He shall not come into this city, nor shoot an arrow there, nor come before it with shields, nor cast a bank against it.—Isaiah, xxxvii, 33.

stationary, fortification is now usually considered defensive, being thus necessarily employed by that side which awaits attack, generally (though not always) the weaker side. The attack, however, now, as in old times, employs fortification to combat fortification, and is perpetually striving to produce some movable defence for aggressive purposes, such as of old were the shields of the ancients, the wooden towers that were wheeled up to the walls of the besieged fortress, or the towers mounted on elephants, and the war-chariots armed with scythes. These latter were really movable forts, from which a formidable plunging fire of missiles could be delivered at any required point of the battle. Several chariots in line would also make a formidable obstacle analogous to a modern street barricade, with the advantage of being able to advance, or retire, as required. Later came the *Pavésades*, a line of shields, each shield or *pavois* serving to cover two men, one of whom held it whilst the other fought, or the whole line advanced under cover. The heavy armour of the middle ages may be said to have converted each knight into a fort,* while those who fought on foot protected themselves with shields or targets.

These old devices for protection are ever re-appearing with new faces, and portable fortifications are constantly being recommended for adoption in some form or other. Thus the war-chariots of the early Greeks and Assyrians may be considered the prototypes of the iron-plated railway battery; the wooden towers and "*pavésade*," of the movable steel mantlets (so ably advocated in this room not long ago),† and the missile-catching shields of the musket-proof knapsack,‡ which has also its supporters both at home and abroad. (See Appendix 1.)

Yet we engineers, as a body, like those of old, prefer going to our mother earth for aid and protection, and to "cast a bank" with a simple spade, rather than rely on more cumbrous defences. It was in moving earth that the Roman legions conquered the world, and although our ambition is limited to holding our own, we shall do well to take a lesson from those grand old pagan soldiers, "to whom," in the language of Gibbon, "the use of the spade and pickaxe was no less familiar than that of the sword or pilum. Active valour may often be the present of nature, but such patient diligence can be the fruit only of habit and discipline."—"Decline and Fall," &c.)

In the wars of the middle ages, Charles V and the Prince of Parma appear first to have restored field fortification to its due prominence in tactics. Charles V attached to each regiment of *Landsknechts* a company of pioneers of 400 men. This company, placed under the command of a special officer, carried with it a little pack of tools, and in

* It was not until the commencement of the 18th century that defensive armour for infantry was entirely abolished in France.—G. G.

† See "Journal of the Royal United Service Institution," No. lv., page 326, vol. xiii.

‡ This is, I believe, the only *personal* portable defence advocated, with exception of an invention by a Signor Muratori, of Turin, described as a cuirass of cloth or canvas (which has previously been treated with some preparation). This cuirass is reported to resist easily a powerful bayonet thrust or revolver bullet fired at half-a-dozen paces. (Report of a Professional Tour of Officers of Royal Artillery in 1863).—G. G.

fact corresponded to our present Royal Engineer train. The Prince of Parma had a similar organization, and his army numbered 3,000 pioneers, who were reinforced as required by workmen taken from the infantry.* Colonel Brialmont states that since the time of the Prince of Parma's famous siege operations, the custom of having troops specially entrusted with the execution of field-works seems to have fallen into disuse, such works, in the subsequent wars of the Princes of Nassau, Gustavus Adolphus, Louis XIII and XIV, being the forced or voluntary work of the country people. "Historians agree that soldiers objected to the use of intrenching tools, notwithstanding the laudable efforts made by their leaders and sovereigns to overcome this prejudice."† Our own army in the Peninsula was strongly affected with this feeling, thus Sir John Burgoyne, in his "Military Opinions" (p. 286), says:—

"Works are not executed by the British in the time they should be, nor with the alacrity with which they are in other services. I have known our men (the line) refuse to take out their gabions and set to work. I have myself placed, at different times, hundreds of gabions with my own hands, and then *entreated* the men to go and fill them, but to no purpose."

"In short," says Sir Francis Head, "in the Peninsula these noble fellows trained to fight in the open, like the generals who commanded them, disdained either to seek or make cover of any sort."‡

A good deal of this feeling still lingered among our soldiers of the Crimea, but now it is fast dying out, and, with more instruction, we may hope to see it altogether disappear. We have good grounds for believing this when we note the gallant spirit with which the 2nd battalion of the Scots Fusilier Guards devoted themselves to field-works in the Tower ditch last summer, voluntarily and without any remuneration. When we see such a distinguished corps as this take up the spade and show intelligent interest in their works, we may consider that the time has passed away when our Army, like Gallio, "cared for none of these things."

In the highly disciplined Army of Frederick the Great, (long our model for drill) the soldiers had to work when required, like the Roman legionaries. At Bunzelwitz, for instance (20th August, 1761), for three days and nights one half his army (25,000 men) were constantly at work; but it would trespass far beyond the limits of this paper to narrate the many instances when intrenchments rapidly thrown up on the eve of action, have changed the fates of campaigns, and perhaps of nations. This is attested in the Seven Years' War by the fields of Reichenberg, Kunersdorf, and the camp of Bunzelwitz; later by Jemappes, Fleurus, Caldiero and Borodino. It is sufficient to note that all the greatest Captains of modern times, Turenne,§ Saxe, Frederick the Great, Napoleon, and (as far as his means permitted) the

* "La Fortification Improvisée," par A. Brialmont.

† Idem.

‡ "The Royal Engineer," by the Right Hon. Sir F. B. Head, p. 350.

§ Turenne rarely neglected to fortify his camp, covering it by small detached works, furnished with abatis, &c. These works (very similar to shelter-trenches), for

Duke of Wellington, have declared and testified for all time their sense of the value of fortification in the field. "Field-works," said Napoleon at St. Helena, "are always useful, never injurious (nuisibles) when well understood."* Our own history illustrates this fact as well as any other. Thus, at a very early period two of our proudest victories were gained with the aid of intrenchments. At the battle of Crecy, August 25th, 1346, Edward III. threw up trenches on his flanks and intrenched his baggage (Foisart, chap. 126, Hume, vol. ii.). At Poitiers (Sept. 20th, 1356) where 12,000 English stood opposed to 60,000 French, the Black Prince strengthened his well chosen position by intrenchments during the night before the battle (Froissart, chap. 160, Hume, vol. ii.). Since the days of Crecy and Poitiers, our records of intrenchments used in battle are scantier than those of Continental nations. Yet we must remember the great lines of Torres Vedras, before which Massena (Napoleon's spoilt child of victory) vainly chafed and fretted away his strength; the intrenchments of Fuentes d'Onoro, thrown up in presence of the enemy, by which the same general was again foiled in his purpose; the central redoubt at Talavera,† where Campbell successfully repulsed the French attack; also Hougomont and La Haie Sainte at Waterloo.

Yet these are only noted occasions where field-works have had a direct undeniable influence on actions, but how many cases must there have been where temporary fortifications, such as bridge-heads, intrenched outposts, and works of lesser importance may have indirectly contributed largely to influence the operations of the campaign, although unnoted and unknown by the military historian, and perhaps by the Army in general!

Sir William Reid, for example, in a valuable paper "On Intrenchments as supports in battle" (Professional papers, R.E., vol. 2, old series) mentions an officer of the 52nd Regiment who, being in charge of an outpost during the operations of the passage of the Nive in 1813, fortified it so well that the pickets had no occasion to retire until they had fired their 60 rounds of ammunition. "Thus the troops for the defence of the main central position had full time to assemble (for it was December, and they were scattered in houses) and to deploy in the position," &c.

Since 1815, intrenchments skilfully planned, appear to have weighed heavily in the scales of victory. Witness the Austrians, who made great use of intrenchments against the Italians in 1848, but none at all against the French in 1859, and who again in 1866 at the fatal field of Königgrätz, made little or no attempt to strengthen the villages in front of their line (Sadowa, Dohalitz, &c.). "The entrances," says Capt. Webber,‡ R.E., "were not even closed; and the strong stone

his first line of infantry, took only a short time to complete. His tools were carried on the crupper by dragoons. ("La Fortification Improvisée.")—G. G.

* "Montholon," vol. i, pp. 213, 219.

† See "Wellington's Despatches," vol. iv, p. 50; also Sir J. Jones's account. No mention of this redoubt by Sir W. Napier.—G. G.

‡ "Notes on the Campaign in Bohemia," by Captain Webber, R.E. Professional Papers, R.E., vol. xvi.

"buildings which were quite capable of resisting field artillery, not even loopholed." The defences of Chlum extended only to the north and north-west sides, while the Crown Prince attacked it on the north-east side. Yet incomplete as they were, the Austrian intrenchments were of great use to them. The Prussians, although attacking, did not neglect the use of field-works, as shown by the strong intrenchments of Dresden, and the defences of Pardubitz.* In the American War, each side made the greatest possible use of intrenchments. Each brigade intrenched itself at the end of the day's march before even cooking their rations. At New Hope Church, writes Sherman, reporting on the Atlanta campaign, the enemy was repulsed, but having hastily thrown up some intrenchments he maintained himself in his position, and next day we found him strongly intrenched; thus our attack was fruitless. At Dallas, on the other hand, the Southerners' assault was repulsed, owing to the intrenchments made by Sherman's troops.†

It is noteworthy that the experience the Americans gained in their three years' fighting led them to multiply intrenchments with great rapidity towards the latter end of the war, as is shown by the battles of March, 1865, round Petersburg, when the same troops threw up successive lines of trenches during action. Quoting the statement of a Federal Officer:—

"Twice had I to change my position in the course of an hour, and each time I left behind me a nearly finished line of intrenchments, so much skill and agility had my men acquired in this kind of work." ("Four Years' Campaigning in the Army of the Potomac," by a Federal Officer.)

This great American contest proved the advantage of cover in all field operations; and the later Bohemian campaign of 1866, by displaying the startling effect of the breech-loading rifle, made it obvious that, in future warfare, troops will have to be kept under cover as much as possible, whether acting on the offensive or defensive.

Marshal Bugeaud said, "If the time for fighting has not arrived, keep yourself out of range, or cover your troops." Had this been written in the era of rifled guns and small arms, he would have omitted the former alternative, which is obviously incompatible with any intention of sudden attack, and deliberate advance under fire from long range is no longer to be thought of.

With the evidence of this before them, the object of the leading military powers of the Continent became to adopt a method of intrenchment offering extreme facility of execution, and no obstacle to advance, so that it might, by rapid successive formations, where required, as much as possible realize the principle of movable attacking fortification, without the disadvantages attending all *portable* fortifications hitherto proposed.‡

* Capt. Webber estimates the length of line in these defences at $3\frac{1}{2}$ miles. They were to be held by 1,500 infantry and 24 guns.

† I have quoted this at second-hand from Col. Brialmont, not having the originals. A great many interesting extracts are also given by Sir F. Head ("The Royal Engineer," pp. 330-335).—G. G.

‡ Il en est résulté une fortification volante qui ne constitue pas un obstacle, mais

Besides these general principles, the consideration of many important details tended to force to the same conclusion; thus, it became evident that, by the introduction of the breech-loading rifle, a soldier in action can obtain cover, where before he would have been insufficiently protected; as, with this arm, he can load while lying at full length on the ground, without changing the horizontal position of his piece, or betraying himself by any movement. In this position, besides being covered, he has the advantage of being able to see an advancing enemy, while the latter can see nothing but smoke, and of firing with at least five times the rapidity of the muzzle-loading rifle, and with much greater accuracy, having a rest for his piece on the parapet. While furnished with this prodigiously destructive power, the soldier in the shelter trench will be protected against the fire of the infantry, and to a great extent, against that of artillery, as we shall see in considering the results of the experiments at Dartmoor last year.

In order to put more clearly before you the opinions of foreign military authorities, I will briefly allude to some late regulations and operations in France and Austria.

To begin with the latter: at the opening of their disastrous seven weeks' war, the directions of Benedek to his troops were, to "avoid standing still before the Prussian lines, oppose their defensive fire by keeping in motion, and charge as soon as you get within 200 or 300 paces." Since 1866, their military reviews enunciate the doctrine that "the tactics of the future will be entirely confined to battles of position and firing." (*Tactique de l'Infanterie*, by Captain Pontus.) A great variety of intrenchments have been designed and tried by the Austrian military authorities in accordance with this view.*

The following is an extract from instructions published by the French Minister of War in 1867:—

"Les bataillons de la première ligne, déployés et couverts, s'il est possible, par des plis de terrain, par des abris, par des tranchées, attendent que l'ennemi soit arrivé à bonne portée pour l'écraser par des feux en masse, surtout au moment de la formation des colonnes d'attaque et lorsque ces colonnes se portent en avant sur la position. . . . Aborder de front, en terrain découvert, une infanterie non entamée, surtout si elle est protégée par des obstacles ou des couverts, a toujours été une opération dangereuse; aujourd'hui surtout, avec les armes nouvelles, l'avantage appartient à la défense.

"Une troupe ayant à parcourir 300 à 400 mètres, sous un feu écrasant, quelque brave qu'elle soit, se trouverait exposée à être détruite avant d'avoir atteint le point décisif de l'action et dans tous les cas arriverait trop affaiblie pour lutter avec succès contre un

un abri pour les hommes.—(Fortification passagère, M. T. Prevost, Chef de Bataillon du Génie.)

* It is needless to say that this principle may be carried too far, and result in a loss of all power of manœuvring; but it may safely be asserted that in future no bayonet charge should be attempted against troops in position, unless they have been previously disorganized by fire, in which case the charge would complete the advantage obtained by the fire.—G. G.

"ennemi préparé à la recevoir et qui au dernier moment prendrait l'offensive."

Colonel Brialmont relates that, after the American war, the French made a trial of rapid intrenchments at Châlons. "Later on a field day at Vincennes, a division of infantry got orders to intrench themselves in presence of the enemy. The operation was protected by a cloud of skirmishers. About one-third the effective strength of each battalion got tools. In less than half an hour the whole division was under cover in well made trenches. This experiment was considered very conclusive (*très concluante*)."

We thus see what is the opinion of those in authority in the leading military nations, but it is well that we should pause to consider how far the reasons that have guided them should affect us, who have our own method of fighting, which cannot be abandoned in mere deference to foreign authority. To do this, we must first glance at the progress that has been made in artillery and infantry-fire since our last European war.

In the Crimea, we were opposed by no arms of precision, except those used by sharpshooters from the Russian rifle-pits, so that we must gather our notions of the effect of rifled artillery from foreign experience in war, and from our own experiments. By comparison of results obtained, it may be roughly stated that where one shot struck before the introduction of rifled cannon, twenty would strike now at ordinary effective ranges (see Appendix No. 2); but this is far from stating the difference between the rifled and smooth bored guns in their relative effects on bodies of troops. A series of very valuable experiments was carried on at Dartmoor last year for the purpose of ascertaining the effect of different kind of shell on targets representing infantry in various formations.

The diagram on Plate XXXII, shows the number of hits produced by 15 rounds of 12-pounder rifled segment shells, at 1,000 yards, on 15 men in single rank, standing, kneeling, and in shelter trench.†

It would have been better, had time permitted, to have had the results noted at the end of each round, as it is, I cannot give any correct statement of killed and wounded from this diagram, many having been killed and wounded several times over. Thus numbers 4 and 5 of this diagram have received 25 hits each, the total number of hits being 196. As might be expected, the effect of shell on columns is much more remarkable; thus in experiment No. 13, at Dartmoor, 15 rounds of 12-pounder segment shells (with E. time and C.F.S. percussion fuze) were fired against targets representing 6 companies of 27 file each, drawn up at quarter distance behind a slope, so that only the top of the front row was visible. At a range of 1,700 yards, this column was struck in nearly 1,000 places (949 hits). Another experiment (No. 31) was tried on a similar column, partly retired behind the crest of a hill, at 1,670 yards with the same shell (C.F.S. percus-

* "La Fortification Improvisée," pp. 16 to 19.

† The hits were copied off the official diagrams, kindly lent me by Captain Alderson, R.A.

Results of Practice with 15 rounds of 12 P^r Segment shell on a single rank of 15 men
Corresponding to 5 Dartmoor Targets 6' x 6'
Fig. 1. Standing.

Target N° 5

Target N° 6.

Target N° 7.

Fig. 2 Kneeling

Target N° 5

Target N° 6.

Target N° 7.

Fig. 3. In Shelter Trench

Target N° 5

Target N° 6.

Target N° 7.

of bottom of target) is 15 inches below A.A', the level of top of parapet. D.D. therefore in Fig. 2
'throughs' only count, between B.C. only whole shell, & between C.D. (being below ground level) the me
rounds of 12 P^r segment shell at 100 yards on targets 4 to 3 Obtained by Exp^s N° 4 at Dartmoor. N° of 10

sion fuze), and this time with 15 rounds, the column was struck nearly 1,200 times (1,194 hits).

This alone should be sufficient to convince us that troops can no longer be exposed to artillery fire within effective range of segment or shrapnel without cover.

Turning from artillery to small arms, we find the progress in the science of destruction since our last European war, even more astonishing. In order to assist us in estimating the difference between the arms of the smooth-bore period and the latest breech-loaders, I will quote the following extract from the text-book in use at the School of Musketry (p. 110, et seq.) :—

“ The shooting powers of the percussion musket, 1842, are shown in a report on ‘ Experimental Musketry Firing,’ carried on by Captain McKerlie, of the Royal Engineers, at Chatham, in 1846, which concludes as follows :—

“ ‘ It appears by these experiments that, as a general rule, musketry fire should never be opened beyond 150 yards, and certainly not exceeding 200 yards. At this distance, half the number of shots missed the target, 11 feet 6 inches, and at 150 yards, a very large proportion also missed; at 75 and 100 yards every shot struck the target 2 feet wide, and had the deviation increased simply as the distance, every shot ought to have struck the target 6 feet wide, at 200 yards; instead of this, however, some were observed to pass several yards to the right or left; some to fall 30 yards short, and others to pass as much beyond; and the deviation increased in a still greater degree as the range increased. It is only then under peculiar circumstances, such as when it may be desirable to bring a fire on field artillery, when there are no other means of replying to it, that it ought ever to be thought of using the musket at such distances as 400 yards.’ ”

After the interesting paper read here, and published in the Journal of this Institution (The Martini-Henry Rifle, by Capt. V. D. Majendie, R.A., No. 1v, Journal of Royal United Service Institution), it is unnecessary for me to say much about breech-loaders, but it is curious to compare these records of Old Brown Bess with some of the achievements of that latest, deadliest combination, the Martini-Henry. Captain Majendie gives the following as averages of 5 targets of 20 shots each with this arm :—

At 300 yards, mean deviation	..	·57 feet
500 " " "	..	·95 "
800 " " "	..	1·63 "
1,000 " " "	..	2·80 "
1,200 " " "	..	3·46 "

As regards rapidity, a rate of fire, without aiming, of 20 rounds in 48 seconds, equal to 25 shots a minute, has been obtained.

This will make battles somewhat different to what they were when a man was safe at 200 yards, and when, as military writers have estimated, not more than 1 ball in 10,000 attained its mark, though of course the practice of the rifle range is not that of the battle field,

where allowance must be made for haste and excitement, exaggeration of distances, &c. More experiments, especially in volley firing, which the tactics of the day prescribe for breech-loaders, will have to be made before the relative value of the Martini-Henry to its predecessors can be accurately determined; but it is evident that we have got a weapon of wonderful power, especially in defensive positions.

Besides this, we hear of a new arm of most formidable character, which has already been introduced into the French service, "The Mitrailleur."

In a valuable paper on this subject (Journal of Royal United Service Institution, No. lvi), Major Fusbery informs us that the Montigny Mitrailleur (which may be described as a gun composed of 37 rifle barrels) will send 414 shots per minute with great accuracy up to 1,200 yards, and that without requiring to relay the gun after once ascertaining the distance. In conclusion he remarks:—

"Deliberate and continuous movements, in face of either artillery or infantry, will become more and more impossible, and we shall have to prepare for short and rapid concentrations from extended order, or sudden rushes from cover, natural or artificial," &c.

Captain Majendie, R.A., thus concludes his paper on the Martini-Henry:—

"What we have now to do is, to seek an efficient and ready means of defence for our soldiers against these terrible arms of precision, which can pour forth such an amazing stream of fire, consuming all it touches. We may, by the establishment of a system of field intrenchment, do much to afford cover and concealment to our men," &c.

These remarks from Officers who have been specially devoting themselves to the study and development of arms of precision, are well worthy of our attention.

A few trials were made at Dartmoor of the effect of artillery fire upon hasty intrenchments, or shelter trenches thrown up by infantry, in from 18 to 24 minutes (see Figs. 9 and 10, plate XXXIV), dummies being placed behind these intrenchments, so as to represent infantry kneeling and firing. It is unfortunate for our purpose that no experiments were tried against dummies in the same position without shelter trenches. However, by counting the hits on the official diagrams that would have struck men standing or kneeling without cover, or firing from shelter trenches,† we may arrive at an approxi-

* "Journal of the Royal United Service Institution," No. lv, p. 380.

† For this purpose, I constructed diagrams (on a scale corresponding to the large photographs of a single rank of 15 men standing and kneeling, as exhibited in lecture room) of the targets, representing the front ranks in experiments Nos. 2 and 4, on tracing cloth, applied them to the photographs, and counted all hits on the figures. To obtain the probable results on the same kneeling rank if protected by a shelter trench, the ground level (or foot of the target) was taken at 15 inches (the height of the parapet) below the muzzle of the rifle, then all "throughs" were allowed to count for 6 inches from top of parapet; below that, only entire shells which would have gone through the parapet. Above the line of the crest, of course all hits on the figures were counted. Diagrams in Plate II show the relative number of hits standing, kneeling, and in trench, with shrapnel at 1000 yards.—G. G.

DIAGRAM No. II with 15 rounds 107 hits on 15 men in single rank kneeling

DIAGRAM No. III, with 15 rounds 40 hits on 15 men in single rank in shelter trench

Target No. 4.

No. 5

No. 6

No. 7

No. 8

PLANS AND SECTIONS OF SHELTER TRENCHES, GUNPITS, ETC.

Fig. 3.

II 67.1

REFERENCES

Fig 5 Grapple for logs excavated by 3 turners.
Fig 6 Lumber pit for lumber & 2 horses, excavated.
Fig 7 Home pit for 4 horses excavated by 3 turners
Fig 8 Section of highway trench excavated by Indian.
Fig 9 Section of
Fig 10 to 14. Sections as shown by letters.

and for 2 vines standing area 6.62 sq. ft.
" " kneeling " 3.28 "
" " 2 bushes 11.79 "
area 19.69
ascade - above sectioned area 1.64 ft.

mate estimate of the number of hits saved by the shelter trench parapet. In order to make the comparison, I have taken the hits on targets 4 to 8 only, giving a front of 30 feet, the length of the 18 minute shelter trench.

No. of Experiment.	Gun and Projectile.	Range.	No. of Hits. Standing.				No. of Hits. Kneeling.				No. of Hits. In shelter trench.				Percentage saved by trench.
			T	L	S	Total.	T	L	S	Total.	T	L	S	Total.	
4	12-pr. M.L.	Yards.													
4	Shrapnel..	1000	140	5	21	166	91	4	12	107	30	3	7	40	75
4	Segment..	1000	88	17	61	196	57	25	27	109	24	10	2	36	81
2	Shrapnel..	1200	28	6	8	42	17	1	5	23	5	1	1	6	86
2	Segment..	1200	11	14	23	50	2	3	4	9	1	2	1	4	92

This gives, as the average percentage of hits saved by the trench, 83½, a result very closely confirmed by comparison with the actual practice at the shelter trench on the 10th July, thus:—

Experiment No. 2, 15th June, 1869. Against targets 4 to 8.

		Hits. per round.	Range.
Front rank only, with front of 30 feet	{ 8 effective rounds 8 ditto	Shrapnel 42 5·25 Segment 50 6·25	1,200 yards.

Experiment No. 2, 10th July, 1869. Against shelter trench.

		Hits. per round.	Range.
18 minute trench, front rank only; front of 30 feet...	{ 2 effective rounds 7 ditto	Shrapnel 3 1·5 Segment 3 4·3	1,200 yards.
Percentage saved by trench with Shrapnel		72	
Ditto ditto Segment		93	
Average percentage saved by trench		82½	

We arrive, then, at this result, that for every 100 hits on a single rank of men standing upright there will only be about 18 hits on the same number of men occupying the same front if firing over the parapet of a shelter-trench. Had we the means of making a similar comparative statement of the number of hits received by a line two-deep, first standing and then intrenched (front rank kneeling and rear rank lying, as shown in Fig. 1, plate XXXV), we should of course obtain a much larger percentage of hits saved. As it is, I feel convinced that the saving shown by the above calculation very much under-states the protection afforded by shelter-trenches against artillery fire.* Thus, the supposition

* The Committee divided the hits into shots, or splinters that went through the targets ("throughs"), others that lodged ("lodges"), and others that only dented or struck ("strikes"), and only two-thirds of the latter were allowed as hits. I have

in these diagrams, and in the trials against shelter-trenches at Dartmoor, is that the occupants of the trench would always be in the act of firing over the parapet, whereas (since no artillery Officer would, if he could help it, bring his guns within rifle range) they would more probably be lying down under cover. (See illustration, Plate XXXVI.) Besides this, the usual condition under which guns would come into action against shelter-trenches would be that of firing at an unknown range, and considering that the difficulty of seeing the trenches at all at Dartmoor from very moderate ranges was so great that flags had to be put up to show their position (although no previous attempt had been made to conceal them by branches or heather), I cannot believe that, even with Captain Nolan's telemeter, it will be an easy matter to ascertain their distance. The difficulty of striking these low earth-works was indeed shown very clearly by the experiment on July 9th, when twelve rounds of shrapnel and twelve of common shell were fired with the intention of bursting them in the parapet of the trench, "but," as stated in a report, "none could be made to strike in exactly the proper place, notwithstanding which, the practice must be considered as very good, as an error of one or two feet in elevation would be sufficient to account for the distance under and over at which the shells struck."*

Thus, then, twenty-four rounds of deliberate practice, by first class artillerymen, knowing the range, and with nothing to disturb them, *produced absolutely no effect whatever on a shelter-trench at 1,500 yards.*

In order to ascertain the value of shelter-trenches as a protection against musketry, it would be very desirable to have some experiments made to ascertain the relative efficiency of two bodies of infantry, one behind a shelter-trench, and the other advancing to the assault. At present all we know is that any parapet over twenty inches thick is proof against the best rifle. The following statement has been supplied to me by an Officer† who has made many experiments with the new rifle, "Supposing an attacking party 400 strong has to advance against 100 men, armed with Martini-Henry rifles, and well sheltered, 50 to fire and 50 to provide them with ammunition, time advancing three minutes, *by the end of the second minute there ought not to be a man left standing.*"

As this paper will not have the advantage of being discussed at this meeting, I propose, before proceeding further, to notice the principal objections that I think can be made against the use of intrenchments in battle.

‡1. "The use of shelter-trenches is contrary to the spirit of modern

preferred counting everything as a hit. Very little suffices to disable a man, and a man disabled is for military purposes better than a man killed, as he takes off other men to attend to him. According to French experiments, a ball penetrating 16 millimetres (.63 inches) into deal will disable a man.

* Report on Dartmoor Experiments, by Lieutenants Day and Cockburn, R.E.

† Capt. Drake, R.E., Musketry Instructor. See Appendix No. 3.

‡ These first two objections are borrowed from Captain Charriaux, of the Belgian Army, proposer of a musket-proof knapsack. (See "Spectateur Militaire.")

CHATHAM
SHELTER TRENCHES, &c.

Fig. 1.

Fig. 2.

Fig. 3.

Fig. 4.

Shelter Trench for 1 Company

Charger Pits

Fig. 5.

Fig. 6.

Fig. 7.

Fig. 8.

Shelter Pit.

Section on A.B.

Fig. 9.

Section on C.D.

Scale for Fig. 1, 2, 3, 8, 9. 5 ft. to 1 inch.

" " " 5, 6, 7. 10 " " " "

" " " 4. 20 " " " "

BATTALION LYING DOWN IN LINE.
HELTER TRENCH IN THE OPEN

BATTALION IN ACTION IN LINE.
HELTER TRENCH IN THE OPEN

"tactics, which requires the utmost flexibility and rapidity of movement."

Reply.—Flexibility is quite compatible with the use of shelter-trenches, which should offer no impediment to the free transit of troops; rapidity of movement is obviously not affected by them; *continuous* rapid movement certainly is incompatible with their use, but unresting rapidity is impracticable, and to attempt it would be worse than useless before rifled guns and breech-loading rifles.

2. "The ground is not always fit for intrenchments, the Army may find itself in a marshy plain, or amid shifting desert sands, or worse still, on bare rocks."

Reply.—This may happen, but even in such exceptional cases the troops will be all the better for having been taught to cover themselves; among rocks they will probably not need other than natural cover.

3. "Trenches demoralize the soldier, who learns to crouch behind parapets and to fear exposure."

Reply.—On the contrary, they demoralize the soldier who has to attack them by adding to his difficulties and losses. As, however, this is a stock argument against intrenchments, I propose replying to it at greater length.

Does training a soldier and making him more able and intelligent demoralize him?

Those who hold it does, are consistent in believing, that teaching him how to protect himself, demoralizes him. It has been said by many that the trenchwork before Sebastopol demoralized the soldiers; that they lost the dash and daring of British troops and clung to parapets when they should have gone forward. As one who served in the trenches throughout that siege, I wish to give my testimony against the notion that the trenches demoralize the men. I believe that those who originated these sayings have generalized too much on individual cases, perhaps of recruits who never were soldiers, or of old soldiers who never were good ones, and that they have hastily attributed these shortcomings to the trenches. Sickness and suffering, disappointment and doubt, demoralize men, and all these our soldiers had to bear up against during that long siege. But we Engineers cannot admit that the trenches demoralized them. What troops had so much trenchwork as our Sappers, and who will say that they ever shrunk from exposing themselves when required? It is unnecessary to give instances of this, as they were doing it every day and night of the siege, when "follow the Sapper" was the order of march. I would not have noticed the Sebastopol illustration, but that I know it is often brought forward, for after all what comparison can there be between the trenches of Sebastopol, where men did duty for nearly a year, always more or less under fire, usually with very little chance of returning it, and troops lying for a short time under cover during action, either engaged, or awaiting an order to advance?

An objection has been put to me in the form of a dilemma, thus:—

4. A battle is either fought offensively or defensively; if the former then shelter-trenches are useless, if the latter, unnecessary, the best defences being detached works like those of Torres Vedras.

Reply.—This assumption is incorrect, as unless the forces are very unequal, no battle can be purely offensive or defensive. All authors agree “that defensive positions are best maintained by offensive actions”. (see Sir Wm. Reid’s paper), or, as the French express it, “Combat défensif avec retour offensif.” “Les armées offensives elles-mêmes ne sont pas dispensées de se fortifier; car elles ne sont pas toujours et en tous lieux supérieures, et elles ont à prendre quelques précautions sur leurs flancs et sur leurs derrières. . . . elle se dégarnira en certains points, se contentant d’y observer son ennemi, pour agir ailleurs avec la meilleure partie de ses forces. . . . elle ne doit pas négliger. . . . de couvrir par des retranchements légers, ses grandes gardes et ses avant postes; la prudence veut aussi qu’elle protégée également, par quelques postes retranchés, ses derrières et sa ligne d’opérations.” (Noiset’s Fortification.) The improvements in arms of precision (especially musketry) have made the defence so much stronger than the attack, that the principle so prophetically enunciated by Napoleon must now be acted on, that tactics should be based on fortification. On this principle, no Army in a defensive position will in future be attacked without previous counter-battering from guns protected by earthworks, while the troops of the first line are kept ready for the assault in a parallel of natural or artificial cover.

With reference to the character of the works of defence it will, I apprehend in future warfare, be found inadvisable to concentrate troops in detached forts without bomb-proof protection or covered communications (which hasty intrenchments cannot have). Natural cover between the forts must, therefore, be improved (commencing with mere shelter trenches) as much as possible, and the main body of troops kept in line in these intervals when most capable of taking the offensive.

At this point the question previously put may be answered, viz.: Is the use of shelter trenches compatible with our English mode of fighting?—Yes; because it is peculiarly well suited to our line formation, and therefore our troops would adapt themselves more easily to it than those of Continental nations who fight in column. To our troops, no change of formation would be needed in an advance from the line of trench, and to them there would be no change of tactics in receiving a charge in line.

To some, perhaps, it may still appear unmanly, or un-English to be under cover; but I can only allude to this feeling as a mischievous piece of sentimentalism which ought to be rooted out. Let us not in any future war sacrifice our men to any such puerile considerations as these; let us not again merit the reproach of the historian of the Peninsular campaigns: that “in the beginning of each war, England has to seek in blood the knowledge necessary to ensure success.”

We have now to consider what form of trench is best adapted for the field. Fig. 1, plate XXXIV, is the profile recommended by the French; it is large enough for two ranks and gives cover to men firing standing. Fig. 2 is for two ranks kneeling; in both, the parapet is thick enough to resist musketry.

Shelter trenches of this kind have been thrown up in the French

camps in 25 minutes in ordinary ground, and in 35 minutes in very difficult soil. In July, 1868, the Italian Army, encamped at Fojano, made shelter-trenches with untrained troops. 150 men in 25 minutes made a trench of 93 metres length in stiff clay, and later 128 men made in similar soil a trench of 100 metres in 30 minutes.

The Austrians have made many experiments in shelter-trenches. Fig. 3 shows the profile recommended by them.* Fig. 1, plate XXXV., is the Chatham section for a shelter-trench as given in the Field-book of Instruction. "Such a trench can be executed by men with their accoutrements on, distributed at from 4 to 6 feet intervals in from 10 to 20 minutes. This is the smallest trench that is of any use and will afford cover to two ranks, one kneeling in the trench and one lying in rear of it." This trench can be widened, as shown in Figs. 2 and 3, or men skirmishing may make shelter pits for themselves, such as shown by Figs. 8, 9, plate XXXV. This may be made in from 2 to 4 minutes with very little practice by one man of a file of skirmishers. The same thing is practised by the French (*embuscade-abris*). See Fig. 4, plate XXXIV. Branches, bundles of underwood, &c., may be used for screens. Charger pits may sometimes be necessary, such as shown by Figs. 5, 6, 7, plate XXXV. This can be made by four men in half-an-hour.

Plate XXXVI is a photograph from a spirited drawing by Lieut. Conder, R.E., showing a detachment in line both in action and at rest, with or without protection. The advantage of the parapet is too evident to need further remark.†

Figs. 5 to 14, plate XXXIV., show plans and sections of the shelter trenches, gun and limber-pits used at the experiments at Dartmoor, already referred to.

Two gun-pits were made, each for one gun and its detachment—excavated by seven gunners in one hour. A roughly-constructed model of a field-gun, and six dummies to represent the detachment, were placed in each.

Experiment 1 was with 12-pounders at 930 yards. Results: with shrapnel, 2 killed, 2 wounded, gun and carriage untouched; with segment, 2 killed, 1 wounded, gun and carriage marked by splinters.

Experiment 2 was with 12-pounders, at 1,525 yards; 12 rounds were fired with each. Results: with shrapnel 2 killed, carriage injured; with segment in gun-pit *nil*; but, in limber-pit, limber much injured, horse killed. On the 9th June, 12 rounds of segment at the same range were again fired at this pit with no results.

This practice seems to have led some Artillery Officers to the conclusion that gun-pits are of little or no use; but I would submit to them, for further consideration, that the conditions under which these experiments were conducted were not precisely those of war. Thus, the exact range was known, the gun-pits were isolated works, so as to show a distinct mark to the gunners, whose aim was further assisted

* Taken from Col. Brialmont's pamphlet, "La Fortification Improvisée."

† It will be observed that this drawing is taken from a very commanding position, in full view of the parapet of the charger pit, which would otherwise be hardly visible over that of the shelter-trench.—G. G.

by small flags planted in the parapet, though it is true they had not the flash and smoke of answering guns to guide them (if, indeed, that is a guide beyond point-blank range). Then the gun-detachment being dummies were always standing at their guns instead of running in occasionally and "hugging the parapet," as sensible *live* gunners would do, between the rounds; at all events, to test the value of the protection, some similar dummy gun-detachment ought to have been placed in the open and fired at from the same range. In 1862, a trial of this kind was made by the Ordnance Select Committee at real guns and carriages. They report the result of 12-pounder segment shells at 1,000 yards as follows:—"The carriage of the gun fired at with segment shells was "severely cut up, one wheel being completely destroyed." Later in the year, they renewed the experiment at 600 yards, this time providing the gun with a dummy detachment. The results of firing with the 12-pounder gun was then as follows:—"All the detachment "were struck, several of the dummies were cut to pieces; carriage described as being knocked to pieces; portion of a wheel "carried 30 yards to the rear." It is therefore evident that bad as the inside of a gun-pit may be under artillery fire, it is better than the outside; besides, it must be remembered that gunpits are also intended as a protection against Infantry fire, and although unfortunately no experiments with small arms were made at Dartmoor, yet we know that a rifle bullet will not penetrate more than 12 inches of earth at 220 yards, and that the exposure of gunners firing from a gun-pit is certainly not one-quarter that of the same men unprotected. By the experiments at Hythe in 1856 with rifle practice against guns and dummies at 800 yards, it was shown conclusively that artillery would be beaten off the field by infantry, armed even with the Enfield.

A similar experiment was tried in Austria a short time since, when a company of infantry of 200 men opened volley fire on a field battery (8 guns), having dummy men and horses, with the following results:—

At 1,000 yards—126 hits out of 1,100 shots, or $11\frac{1}{2}$ per cent.

800	"	250	"	"	1,460	"	"	18	"
600	"	299	"	"	1,600	"	"	19	" nearly.

Thus at 1,000 yards they would have made 115 hits per minute, at the deliberate rate of five shots per minute, or sufficient to disable the entire battery in one minute.*

The following is a brief account of the method of forming shelter-trenches as practised at Chatham in accordance with the drill instructions now preparing for issue:—

The battalion having been formed in quarter column on one flank of the tools, the rear ranks file out, each man taking a tool as he passes the markers, who distribute shovels to all the odd, and picks to all the even numbers. On the march the tools are transferred from one rank to another, to relieve the men, but on arriving near the position of the proposed shelter-trench, the tools are again taken by the rear rank,

* See also an interesting paper on this subject by Lieut. Walkey, R.A., in Proceedings of R.A. Institution, December, 1866.—G. G.

who form the trench, while the front rank open fire or lie down, or remain standing in advance, according to circumstances. The markers are then ordered out and placed along the intended line of trench, usually following the contours of the ground; the rear rank in the mean time form two deep, pile arms and prepare for work. The line of trench may then be marked with picks or tracing tapes. About three-fourths of the odd numbers of the rear rank then extend at double arm distance, touching each other with extended hands, dressing by the markers, who extend one arm. The odd and even numbers then work together in pairs, each pair occupying about $5\frac{1}{2}$ feet of ground, and making the trench 2 feet wide and $1\frac{1}{4}$ feet deep, only one man working at a time. To place the men thus, takes usually about two minutes from the time of arrival on the ground to the moment of commencing work. The remaining quarter of the rear rank are employed on the trenches for the officers and supernumeraries, and on the charger pits.

The Austrian method is to place two men to every 3 Austrian feet run (about 3 feet 8 inches English), thus employing two-thirds of the number of men to be covered. This must cramp their working powers, being too confined. The French place one man per metre (about 3 feet 4 inches), and thus employ one-third the number to be covered.*

Colonel Brialmont proposes forming the battalion with double files, carrying shovels, alternating with single files carrying picks; halt them at four paces from the site of the trench, and open the ranks, laying arms and packs on the ground; the front rank then advances with tools, each group of three establishes itself in a portion (*atelier*) of 1.80 metres in length (corresponding to the space occupied by three men in the ranks, 5 feet 10 inches, or 23.72 inches per man). Two of these men have spades, the third a pick. This latter places himself between the two first and in rear of them. After 10 minutes' work, the men of the second rank who are lying down behind their arms, relieve those of the first rank. The intrenchments are thus executed along the whole extent of the front with the co-operation of all the men. One half of them guard the other half, and in less than a minute, in case of unforeseen danger, the battalion would be under arms.†

As may be seen, therefore, the main points of difference between our method and that employed on the Continent are—1st, that we use equal numbers of picks and shovels, while they use only one pick to every two shovels; and, secondly, that they make no provision for supernumeraries, &c., who, they say, can enter the shelter-trench with the men, or sit on the reverse of it when large enough.

With reference to the 1st point, we find it best to provide equal numbers of picks and shovels, our men always working by files or pairs, and in the shelter-trench, as only one works at a time, he has both pick and shovel at his command. As regards No. 2, it is considered better for purposes of supervision and discipline, to have distinct positions for the officers, &c.

* Six workmen, four shovels and two picks, to 5.20 metres length (≈ 17 ft. nearly) = a space of nine files, or 18 men, each file in the ranks occupying about 58 centimetres (22.83 inches).—G. G.

† "La Fortification Improvisée."

It would be beyond the imposed limits of this paper to enter into any description of the application of shelter-trenches to the field of battle. Here the engineer and tactician should combine, the line of front should be in extent exactly proportioned to the number of troops; in fact, "the defences should fit like a garment on the body of the Army,"* loose and free where action is required, close and thick where protection is wanted, in other words, the field should be divided into offensive and defensive portions. In fact, fortification, here on the battle-field as elsewhere, should be employed to economise men, and in this it may be compared to those mechanical inventions which are used to economise manual labour, and especially to such as store up the accumulated results of labour. Thus the fortified posts of a line of battle may be likened to the fly-wheels of a shaft, they are "magazines of power," so that the force expended on them at the beginning will be recovered again at the end.

The preparation of a field of battle, as thus indicated, pre-supposes choice of ground and time for execution. For instance, supposing the army came into bivouac on the position chosen the afternoon of the day preceding the expected action; they rest, if tired by the march, while the General and his Staff reconnoitre and decide on the works to be thrown up. Then, in half a hour before dark, the shelter trenches could be completed, while the more important works of the defence could be executed by skilled troops during the night.† It will be a great advantage in these hasty intrenchments over more solid works, which take longer in execution, that the enemy will necessarily be in ignorance of their exact strength and position. On the other hand, the General of an army acting on the offensive, will make use of shelter-trenches according to his intended tactics and what he expects from his enemy. Thus he may have to intrench an exposed flank, or a part of his line denuded of troops, which are massed for attack in another part. His first line should always be under cover, natural or artificial. Large openings, or intervals between the trenches should be left, sufficient for grand divisions of infantry or squadrons of cavalry on the flanks of brigades, besides the battalion intervals, which might be half those of the brigades. The lines of shelter-trench should be straight or following the contours of the ground—not broken into flanks. In that remarkable paper written 30 years ago, on "Intrenchments as Supports in Battle,"‡ from which I have already made extracts, an account is given how the slight works at Fuentes d'Onoro, thrown up in presence of the enemy, foiled the French attack. Massena explained his failure by representing "the enemy, drawing to their assistance all the resources of fortification against an attack by main

* "Passend wie ein Kleid am Körper der Armee."

† On the defensive parts of the field the shelter-trenches should, if time permit, have the excavation on the front side, so as to offer a greater obstacle to the enemy. See paper by Sir J. Burgoyne on Hasty Intrenchments, vol. xviii., P. P. R. E.—G. G.

‡ By Colonel Reid, R.E., the gifted author of the "Law of Storms," &c. See Sir F. B. Head's humorous, but highly appreciative notice of Sir William Reid, in "Royal Engineer," pp. 298, 299.

"force."—(*Times* newspaper, 29th May, 1811.) "But," says Sir William Reid, "however much every man in that army, at that moment, might have been desirous of availing himself of all the resources of fortification, such was not within his reach; for it is supposed that this portion of the Army had no other intrenching tools than the few carried by the regiments for the purpose;* and there was but one engineer officer present."

The question of tools will have to be considered in connection with this subject; the scarcity and want of them was probably the principal reason why field fortification played such a secondary part in our Peninsular campaign, as the practical sagacity of the great Duke seems to have impressed him with an ever-growing conviction of its importance, of which many instances could be given from his late campaigns.†

Sir W. Reid relates that after the battle of Toulouse, the British Army was to have been intrenched. "Strong country houses were fortified at about every 600 or 800 yards from each other, etc. . . . in rear of the intervals straight trenches were just about to have been commenced when the enemy's army retired." Again at the operations of the passage of the Nive, intrenchments were used. It is indeed pretty certain that the Duke of Wellington contemplated intrenching the field of Waterloo, as is shown by a memorandum of his (dated 22nd September, 1814), on the defence of the Netherlands, quoted by Sir Francis Head ("The Royal Engineer," p. 326), and the same authority states that an order was given on the eve of the battle (too late for accomplishment) to a company of Royal Engineers to march to Braine-la-leud, and there make an intrenchment for the right of the position of Waterloo.

We learn also from Napoleon's Memoirs, that he expected to find the Allies intrenched at Waterloo, and especially charged General Haxo to reconnoitre and ascertain this point. Yet at the battle of Waterloo (as elsewhere, under the Duke of Wellington), although the troops were not intrenched, the principles here advocated of keeping troops under cover until the time arrives for advancing, were carried out as far as was possible with natural cover only.

Quoting again from Sir W. Reid:—"It was the custom during the late war for the British Infantry, when they occupied a defensive position, to draw up just behind, and under cover of the slope of a ridge, when there was one, from whence the lines were brought forward to charge at the proper moment." They were also taught to take advantage of any natural or artificial cover they could find, thus at the battle of Waterloo, the first check to the French attack on Wellington's left centre was from three companies of the

* One mule per regiment for intrenching tools. G. O. Abrantes, 19th June, 1809.—G. G.

† There is difficulty in citing instances, as the cases where intrenchments were used in the battles of the Peninsula appear to have been imperfectly recorded and preserved. Sketches by Sir Phillip Bainbrigge (who was Assistant Quartermaster-General in the Peninsular war) exist, showing that not merely parapets and ditches, but long lines of cover, following the contours of the ground, were constructed by the Duke in Spain.—G. G.

95th Rifles, who were posted in a sandpit and along a hedge in rear of it. Kempt's Brigade lined the hedge of the Wavre road, fired a volley on the French central column (which was in the act of deploying), and then made a charge, but was delayed and somewhat disordered by the difficulty of getting through the hedge. The 79th Highlanders, in particular, suffered greatly, and here it was that Picton was killed.* This shows clearly the necessity that the cover obtained should be of a nature not to obstruct the advance of the troops. Hence the hedges and ditches of cultivated districts are rarely suitable for offensive defence without special preparation; and although natural cover, such as that afforded by gentle slopes and undulations, will continue to be extremely valuable, it will be found in most cases insufficient to protect troops from the explosive projectiles of modern rifled cannon, as was clearly shown by the experiments at Dartmoor (already referred to), against columns partly concealed by rising ground.

Now, at the battle of Waterloo, we know that about 1.30 p.m., Napoleon advanced 10 batteries (74 guns) to within a range of 600 to 800 yards from the English line to support the attack on Picton's division, already referred to. Siborne says, "The nature of the ground permitted the batteries to play over the heads of the three advancing columns of French infantry, and great was the havoc in Picton's ranks."—(Siborne's Waterloo.) Supposing the battle had been fought with the arms and experience of the present day, it is certain that Napoleon would not have advanced his guns within 800 yards, as they could make havoc and destruction enough at double that distance. It is indeed awful to consider what would be the effect of 74 guns acting on unprotected columns† of troops, when we consider the practice at Dartmoor. By experiments 13 and 31, as already stated, a column of targets may be hit over 1,000 times with 15 rounds. Allowing now that one-half of these were caused by "throughs," still 2 rounds per minute from 74 guns would inflict nearly 5,000 hits per minute; sufficient, one would think, to have cleared Picton's division off the face of the earth in ten minutes. But, it may be said, *our* guns wouldn't have been idle all this time, the French would have suffered at least as much as we should. True, on the fair fighting principle of equal exposure, but supposing the French had intrenched themselves, as they did at Chalons, the other day—supposing that Napoleon had devoted one hour, or even one half-hour of the three he spent in parade, to making "tranchées-abris." Who here would wish to see the fate of Europe, the honour of England, risked in such an unequal conflict, and what General would expose his troops to be thus helplessly slaughtered?

Then look at Alma. Our advance—nearly 2,000 yards—over ground swept everywhere by the fire of the enemy's guns, at marked ranges; the storming of the great redoubt, up 200 yards of a glacis slope, in the teeth of guns and musketry; the advance of the Guards "in an

* "Siborne's Waterloo." There appears also to have been an abatis across the Charleroi Road, near the sandpit.—G. G.

† Picton's division at this time was in battalion columns at deploying intervals, as we read that he did not deploy his troops until after the retreat of the Dutch-Belgians (Bylandt's brigade).—G. G.

"array which was all but found fault with for being too grand and too majestic."* Would this be possible against guns such as those used at Dartmoor, and rifles such as the Martini-Henry, in the hands of an enemy practised in the art of getting cover? Of what avail would be the splendour of our line—the majestic grandeur of our advance—against an intrenched body of troops, who would show only the peaks of their caps and the muzzles of their rifles, each rifle being kept steadily resting on the bank before them, and volleying destruction at the rate of 10 to 15 rounds† a minute? Even, with the arms he had, supposing Menschikoff had intrenched himself, could we have stormed the Alma heights as we did, or, indeed, should we have attempted it?

What prevented our assaulting Sebastopol as soon as we arrived before it? Not the ditches, or escarps of the fortifications (which indeed were at that time mere hasty intrenchments growing under our eyes), but our knowledge that works, the approaches to which are well commanded by artillery, cannot be taken except with terrible sacrifice of life, and we knew that, situated as we then were, repulse meant ruin.

I cannot see how, then, we can avoid the conclusion that in future wars, our soldiers will have to protect themselves in the same way as the soldiers of other armies, and that for this we must prepare in times of peace, or we may find it too late when war arrives, and vainly oppose human daring and self-devotion to the inexorable laws of the science of destruction.

Granting, then, that our troops must shelter themselves, it remains for us to consider the means. The question of the transport of tools is one that is surrounded by great difficulties; the root of it is this: Shall the soldier in future carry his tools himself, or get them carried for him? There is strong authority for the former method. Colonel Brialmont states that in Russia, the system of giving every man a tool to carry is on trial; that in Denmark, a tool has been given to each file; in Prussia, to the soldiers of the Jäger battalions only; and that, in the American army, the tools of each battalion are carried according to roster by the men of two companies.‡ (Appendix IV.) Colonel Brialmont himself is in favour of the soldiers carrying their own tools, as their doing so would diminish the "*impedimenta*"—the transport—of the Army, and accelerate the execution of the work. The Drill Committee, in reporting on the instruction of regiments in intrenching themselves, have arrived at the same conclusion, considering that by any other system of transport, the tools would not be at hand when required. There can be no doubt but that there are very strong reasons in favour of adopting this system, and it has the approval of very high authority. Napoleon himself wished every soldier to have a pioneer's tool,§ and indeed made an attempt to get every sapper to carry one, offering "to make it more palatable," that "it should be of

* Kinglake's "Crimea." Quoting observation of a French Officer.

† Of course this rate of fire could not be kept up, but a fraction of a minute might be sufficient.—G. G.

‡ "La Fortification Improvisée," p. 39.

§ "Memoirs at St. Helena," Montholon i, pp. 218, 219.

"superior manufacture, and an implement *de luxe*, as it were; but after much discussion on the objections raised to putting this additional weight on a class of men who frequently had to set to work immediately after a march (*and this will now often be required from all classes of the troops*), he was obliged to abandon the idea."—("Hasty Intrenchments in the Field," by Sir J. T. Burgoyne.)

This difficulty of weight, before which the great military autocrat had to bow and submit, now stands before us, and demands our careful consideration. Many consider that in these days, quick manœuvring and necessity for rapid motion when advancing under fire, will make it obligatory to reduce the weight carried by the soldier below what it has ever been before; and it is a very common opinion, since the short campaigns of Italy and Bohemia, that it will be unnecessary to load him with so much personal kit. The recommendations of General Eyre's Committee embodied these opinions, and I have collected all the information I could find on the comparative weights of different kits (see Appendix V), which I will not now trouble you with. It is sufficient to state, that it is quite feasible to give the soldier an intrenching tool, to increase his present allowance of ammunition from 60 to 100 rounds, and yet to give him less to carry than he has at present, thus:—

Articles to be carried.	Weights (approximate).		Remarks.
	As at present.	As proposed.	
	lbs.	lbs.	
Arms and ammunition	16	20	Including 100 rounds of ammunition, the same as the present French war allowance. For details of Kit, see Appendix No. V.
Accoutrements and pack ..	10	4	
Clothes on person	11	10	
Kit, with blanket	14½	11½	
Food and water	8	8	
Intrenching-tool	..	3	
Total	59½	56½	

But, in attempting to solve this question, the feelings of the soldier himself must be taken into account, and it will not do to answer it merely by making out an arithmetical statement of weights, and supposing it to be a matter of indifference to him what he carries, and that he only concerns himself with its weight. At present, I feel convinced, though I say it with regret, that the British soldier would consider it a great burden and grievance were he to have to carry an intrenching tool in addition to his kit; that he would feel that extra 3 lbs. more than all the rest, and that telling him that the rest of his kit had been lightened on purpose would be of no use. This feeling, or prejudice, is no doubt remediable, and I feel sure that the time will

come when the British soldier will value his spade as second only to his rifle, never to be put aside in the field.

Assuming, then, for the present, that the soldier does not carry his intrenching tool, there remain the three systems of transport to select from, the Army Service, the Regimental, and the Royal Engineer Train. By the first two methods, it is very doubtful whether the tools would ever be at hand when required, as they would be mixed up with all sorts of other stores, and in the not unlikely contingency of deficiency in transport, the tools would probably be left behind in deference, perhaps, to urgent demands for such stores as provisions, ammunition, clothing, &c. The Engineer Train, on the other hand, would feel it a point of honour to have the tools well up to the front; to them their tool-carts would be what their guns are to the artillery; they also would know tools required repair, and draw on the reserves accordingly. It would, however, be necessary to take precautions for obviating the objection made to this system of transport by General Faidherbe,* that "supposing a battalion expects to be attacked, and "wants to get cover, it is necessary to get the General of Division to "give an order to the Engineers of this division to supply tools."—"(*La Fortification Improvisée*.)"

I would propose that each brigade should have a detachment of the Royal Engineer Train, who would carry the light shelter-trench tools for the infantry (one to every three men of the brigade), in addition to the ordinary engineer field equipment. The shelter-trench tools for one brigade would all pack in a wagon (see Appendix VI), and should be entirely at the disposal of the Officer commanding the brigade, or, indeed (if thought desirable), they may be issued to Commanding Officers of regiments. When approaching the enemy, these tools should be issued as required, each being provided with a light strap, so as to be carried without interfering with the use of a man's arms. I do not fear that, in presence of the enemy, and with full proof of its value, the soldier would object to carrying an intrenching tool. In the advanced trenches before Sebastopol, when night sorties were expected, I often found the men of the working parties would not part with their rifles, but carry them on one shoulder, and their filled sand-bags on the other, sometimes, owing to scarcity of earth, a considerable distance.†

This same feeling which led these hard-worked men thus voluntarily to submit to extra labour, in order to be effective if attacked, would soon teach their successors to keep their spades as well as their rifles.‡

* "*Revue Militaire Française*," August, 1869.

† Thus, too, worked the Jews of old at the repairs to the walls of Jerusalem, under their inspired prophet-leader. "For the builders every one had his sword "girded by his side, and so builded" (*Nehemiah*, iv, 18). As a precedent for our shelter-trench drill, we might refer to verse 16 of this chapter, where we read, "And "it came to pass, from that time forth, that the half of my servants wrought in the "work, and the other half of them held both the spears, the shields, and the bows, "and the habergeons."

‡ A mere caprice will sometimes induce a soldier to load himself heavily for a

Whatever system of transport we adopt, it is certain that it must be one which will ensure the tools being always at hand when required. Here, again, Waterloo supplies us with an illustration. As Englishmen, we do not, of course, like to admit that at any period of that great battle we appeared likely to lose it. Yet many writers, and among them General Sir J. Shaw Kennedy (who was present as General Alten's Assistant Quartermaster-General), consider that, when La Haie Sainte was taken, the allied Army was in great peril. "The possession of La Haie Sainte by the French," he writes, "was a very dangerous incident. It uncovered the very centre of the Anglo-Allied Army, and established the enemy within 60 yards of that centre. . . . The danger was imminent, &c. . . . Most fortunately, Napoleon did not support the advantage his troops had gained at this point, by bringing forward his reserves. This peril was undoubtedly, in a great measure, the fruit of the vast importance of holding La Haie Sainte, not having been seen, and the consequent neglect of its defences."* Colonel Chesney corroborates this statement of the critical state of the British Army at this period, and quotes the concurrent testimony of a number of foreign writers. The common reason assigned for the loss of this important post, is the want of ammunition; but, as General Kennedy says, "this is unexplained;" and Siborne supplies another, which may help us to understand why the brave German garrison failed at last after repeatedly repulsing the desperate assaults of the French. "*The mule laden with regimental trenching tools had been lost the day before, so that not even a hatchet was forthcoming.*"—(Siborne's "Waterloo," vol. i, p. 337.) This was a grievous misfortune, especially as, with the recklessness of soldiers, the garrison had weakened their defences on taking possession of the farm on the evening of the 17th, by breaking up the great barn door on the west side for firewood on that wet, cheerless night, so that, in fact, they made a breach in their citadel for the enemy to enter by, and in the absence of their tools—with "not even a hatchet"—they seem to have been unable to stop it up, for we read that the French constantly attacked at this open end of the barn, and ultimately made their way in through it.

Now, if the course of history could be reversed—if the early display of the Prussian force had not drawn off 16,000 troops from Napoleon's reserves, and he had pushed the advantage gained by him through the capture of La Haie Sainte, might not the historian of that campaign have pointed warningly to that stray mule of the 2nd battalion King's German Legion as having carried the fate of Europe on his back? Would that loss have happened had these tools been in charge of the Royal Engineer Train? I answer No, confidently; and ask in return, do we ever hear of stray guns of the Royal Artillery being missed in this way?

One branch—perhaps I ought rather to call it the root—of this subject remains for our consideration; but I have only time to allude very

march; thus Sir J. Burgoyne relates how, in the Peninsula, one man, a shoemaker, carried a lapstone—another soldier a pet dog—in his pack.—G. G.

* "Notes on the Battle of Waterloo," by the late General Sir Jas. Shaw Kennedy, K.C.B., &c., &c., pp. 123, 124, 127, 129.

briefly to it. Our Army, to be prepared for war, requires, above all things, instruction and practice in field engineering; and with a School of Military Engineering at Chatham, it appears strange that measures are not taken for passing regiments successively through a course of field works. The Drill Committee, in reporting on the instruction of regiments, &c., have, however, recommended this measure, and also that regiments should send Officers and Non-Commissioned Officers to the Royal Engineer establishment to form classes, as at Hythe, so that we may hope to see this soon carried out,* and also that at all stations where there is ground available, the troops may be exercised in forming these trenches. It is the wish of many (and I believe it would act most beneficially on the *morale* and *physique* of the Army) to have a *corps d'élite* of pioneers in every regiment. Men of good character, and for the most part knowing some trade—facility for learning trades being afforded to all—these men to be trained at Chatham, and employed under a Regimental Officer of Works, to be available in time of peace for repairs to barracks, and in the field, for engineering duties in connection with their regiments. But the most skilled workmen will be often little better than useless unless their own officers can direct them. Each officer should, therefore, be trained to choose positions, and to lay out intrenchments, availing himself of all natural advantages of the ground. The want of this instruction was often severely felt in the American war. Thus, we read in the reports from the Army of the Potomac:—

“Often the greatest difficulty has been in getting an Army to take up a proper and exact line of defence at first, each regiment, company, and man digging when they find their spades, without reference to the fitness of things, indicating the necessity of more Engineer officers.”

It is, however, in no self-seeking spirit that this is put forward, and I do not think the duties here referred to are such as need Engineer officers *exclusively* for their performance. Well instructed Line officers should be quite capable of performing them, though Engineer officers should be at hand to give advice and assistance as required. Study and practice is all that is wanted to make our Line officers equal to any such emergency, and they must bear in mind what Frederick the Great was in the habit of saying to his officers, “If you wish to learn the art of war, study fortification.”

The CHAIRMAN.—Gentlemen, I am sure that you will all join with me in thanking Colonel Graham for the interesting address he has so kindly given us, on this most important subject—a subject that increases in importance with every fresh development of the destructive powers of guns and small arms. More than thirty years ago, Sir William Reid, to whom reference has been made by Colonel Graham, wrote, that “no army can be complete in its code of field exercise, unless that code includes rules and exercises for intrenchments in battle;” and again, that “the infantry soldier should be taught,

* Were our existing regulations on this subject merely carried out in every regiment as directed, paragraphs 371, 372, “Queen’s Regulations,” a step would be gained.—G. G.

"while he is yet a recruit, that the construction of intrenchments is a part, and a very important part, of his duty." This, I trust, will now be the case in the British Army, as a "Shelter Trench Exercise" has been introduced into the proposed new field exercise, which will next week be submitted to H.R.H. the Duke of Cambridge. And I venture, moreover, to hope that the School of Military Engineering at Chatham will turn out as many skilled instructors and workmen, as the School of Musketry at Hythe does of rifle instructors and first class shots.

APPENDIX No. I.

Portable Defences.

Several different propositions have been made for utilizing the knapsacks as cover for troops when advancing under fire. Captain Charrin, of the Belgian service, and Captain Bennet, of the 7th Fusiliers, propose making the knapsacks musket proof by plates of steel or aluminium.

Major Frank Bolton proposes that each man should carry a steel spade with a movable handle, outside the great coat, the spade answering the purpose of the metal plates in the first proposition; it has also the advantage of adjusting itself to the new valise equipment, whereas the first mentioned would require us to retain the old form of pack.

Under the supposition of troops firing from behind cover, and others making a rapid charge, these heavy plate-laden knapsacks would be a serious encumbrance, besides troops firing behind them could never improve their defences, as occasion might require. Major Bolton's plan is not open to the same objection, provided the men are to be taught to use their spades, and not merely lie down behind them, indeed the best pattern of steel spades (the American) has an area of only five square inches, barely enough to cover a man's head. Major Bolton makes no mention of pickaxes, which, however, would be necessary if the spades are to be used. One great objection to the use of the pack as a defence is that once laid down for that purpose, it would generally in the course of an action be lost sight of, and only recovered with great difficulty, if at all. As Napoleon said, the soldier should never part with his pack.

Captain Harcourt, of the 102nd Fusiliers, has another suggestion to make for obtaining cover. He proposes "that a sandbag and trowel form part of the equipment of every infantry soldier," the sandbag and trowel to fit in a case weighing altogether 1 lb. 3 ozs.

Captain Harcourt states that with this implement, a sandbag can be filled in from two to five minutes, and that a man lying down behind the filled bag is concealed from view at 100 to 150 yards. Having had this trowel and bags forwarded to me by Captain Harcourt, I made an experiment at Chatham with the following results:—

1. With the new London trowel, a sapper (a very good workman) filled the first sandbag in $3\frac{1}{2}$ minutes, the second in 4 minutes, lying covered behind *two* sandbags, in 8 minutes.

2. From the time of standing at attention with Captain Harcourt's pouch on (containing sandbag and trowel) to the time of lying down behind *one* sandbag, 4 minutes. In this case, however, he was certainly not concealed nor sheltered, although zealously striving to be, and reminding spectators somewhat of the popular story of the ostrich.

3. A shelter pit, such as that shown in Figs. 8, 9, 10, plate XXXV, was then thrown up by the same man in the same soil, with ordinary intrenching tools in 4 minutes, giving complete cover.

4. The same sapper then set to work to make a similar pit in the same soil with Captain Harcourt's trowel, and worked hard for 11 minutes without quite completing it. The soil was gravel and stones, underlying a top crust of about five inches turf and vegetable mould. As the trowel had not to go below the mould except in No. 4 trial, the soil was favourable for it.

APPENDIX NO. II.

Comparative powers of Smooth-bore and Rifled Artillery.

The chance of hitting a target 1 metre square, at a distance of 600 metres, with the smooth-bore with 8 lbs. charge, is 4 per cent.; with the rifled Belgian gun of 12, and with a charge of 1,450 grammes 80 per cent. Probabilities of hitting a target 3 metres broad by 4 high with the French 12-pounder howitzer at 1,200 metres is 4 per cent.; with the 6-pounder rifled gun at same distance, 90 per cent.—(Taken from "Etudes sur la Défence des Etats," by Col. Brialmont.)

Captain Noble calculates, according to results obtained with a 9-pounder smooth-bore and a 9-pounder Armstrong gun, at ranges varying between 900 and 1,100 yards, that the probable error in the range of the rifled gun is..... 7.4 yards.

Do.	do.	smooth-bore.....	47.2 "
Do.	in the deviation of the rifled gun.....		9.8 inches.
Do.	do.	smooth-bore.....	8.8 feet.

("On the Theory of Probabilities in Artillery Practice," by Captain Noble.)

The following rectangles for smooth-bore 9-pounder, 9-inch rifled muzzle-loading 9-pounder were obtained from experiments at Shoeburyness:—

Gun.	Elevation.	Range.	Rectangle of fire in yards.	Remarks.
9-pr. S.B. ..	2°	985 yards.	147.2 × 9.1	
9-pr. Rifled M.L.	2°	1,083 „	40.7 × 1.1	Charge 1 lb. 5 ozs.

Trial at Shoeburyness by O.S. Committee, June 13, 1867, on three Rows of Targets, 45' x 6' x 2', 15 yards apart.

Gun and projectile.	Charge.	No. of effective rounds.	Mean range—yards.	Total hits.	No. of hits per effective round.	Remarks.
12-pr. B.L. rifled Segment-shell....	Charge 1½ lbs. Burster 550 grs.	} 9	1,244	510	60	Recorded in Appendix D, of Report on Shrapnel r Segment Committee.
9-pr. S.B.	Charge 2½ lbs.					
Shrapnel.....	Burster 492 grs.	} 23	1,235	221	9.6	

Experiments were also tried with the 12-pounder shrapnel, which are not admissible in a comparative statement, as at that time the proper length of fuzes had not been accurately determined.

APPENDIX No. III.

Martini-Henry Rifle.

Captain Drake, R.E., Musketry Instructor at Gravesend, has kindly furnished me with the following interesting summary respecting the powers of the new weapon:—

"1. The penetration at 700 is about equal to that of the Enfield at 350 yards.

"2. Its accuracy at 1,000 = Enfield at 600 yards.

"3. Its rapidity = Snider x 2 = Enfield x 5.

"That is Snider = $\frac{5 \text{ Enfield}}{2}$.

"In two minutes five men with Martini-Henry rifles will produce twice the effect of ten men with Sniders, owing to superiority both of accuracy and rapidity, and ease of loading."

In the case of an assault on troops posted behind a shelter-trench, and armed with the Martini-Henry, supposing "distance to advance 600 yards, attacking party 400 strong, defenders (Martini-Henry) well sheltered 100 strong, 50 to fire and 50 to provide them with ammunition, time advancing three minutes, by the end of the second minute there ought not to be a man left standing. With the Enfield 80 men ought to be hit in the same time; with the Snider, 160."—M. D.

Lieut. Stephens, R.E., Assistant Musketry Instructor at Gravesend, has also been kind enough to give me the subjoined information respecting volley firing with the Martini-Henry:—"It was found in firing 100 rounds per man by volleys at 800 yards with a section of five men armed with the Martini-Henry rifle at an ordinary volley target 6 ft. by 12 ft., in rough winter weather, that a percentage of 50 hits was made.

"On one occasion, four men firing by volleys at 600 yards with the same arm, made a percentage of 85 when firing 50 rounds.

"It was found that at both these ranges 10 rounds by volleys could be easily fired in less than a minute and a half; indeed that was the actual time taken for any 10 rounds of the above practices when no hurry was made.

"Fifty per cent. of hits would be good for volley firing with the Snider Enfield rifle at 400 yards, and 10 rounds by volleys with this arm could not be fired with effect in less than two minutes and a half.

"The last-named rifle would be of no use for firing in the ranks at long distances.

"Independent firing with the Martini-Henry rifle at long distances, although good, was not so effective as volley firing, and on service would cause great waste of ammunition.

"On one occasion, five men firing independently at a volley target at 300 yards with the sights up for two minutes (the time usually taken to fire 10 rounds with the Snider), placed 112 hits on the target, having fired between them 121 rounds, out of which two cartridges missed fire.

"Men leaning against the parapet of a shelter-trench, besides being protected from the shots which might actually strike the parapet itself, would be a most difficult mark to aim at, and consequently most of the shots fired at them would go over or fall short of them, while they on their part, with the parapet for a rest, would be in a most excellent position for firing with accuracy."

APPENDIX No. IV.

Experiments with Tools.

An ingenious shovel, the invention of Capt. Linneman, of the Danish Army, was tried at Chatham.

Weight of shovel		1 lb. 12 ozs.	} On one side of the blade is a saw, the other an axe; the whole blade will make a frying-pan.
Ditto of scabbard and belt	0 ..	10½ "	
Total weight		2 lbs. 6½ ozs.	

In very easy soil, such as sand, they were found to do very well, but they are useless in difficult soil, as they hurt the men's hands; the saw-edge gets destroyed after very little work, and the axe-edge gets blunted.

Experiments were also tried with a pickaxe and shovel proposed by Col. Bray, and two patterns of American shovels. The portion dug out by each was 4' x 2' x 1' 3" deep, in rather difficult soil, though soft from wet.

Tools.	Weight.	Cubic feet dug.	Time taken to complete.	Remarks.
Service pick And shovel.....	7 lbs. 9 ozs. 5 „ 2 „	} 10	11 minutes	
Colonel Bragg's..... } Pick and shovel.... }	P. 5 lbs. 6 ozs. S. 4 „ 11½ „	} 10	14½ minutes	Rather clumsy, considering its weight; thumb-screw and blade-work loose.
Chatham pick..... American shovel, No. 1	2 lbs. 8½ ozs. 2 „ 4¾ „	} 10	11 minutes	Soil rather easier than the others, pickaxe broken before completion, which caused some delay. Best supper working.
Chatham pick..... American shovel, No. 2	2 lbs. 10½ ozs. 2 „ 3 „	} 10	16 minutes	The rounding of the corners prevents the foot being used with this shovel.

A crutch is much wanted on the ends of the handles of the American shovels. The steel blades clean themselves much better than the blade of an ordinary shovel. The shovel without the shoulders rounded off (No. 1) can be used very well as a spade, the blade being stiff and strong, and there being plenty of room for the foot. The blade might with advantage be made a little longer, and the handle perhaps a little lighter towards the ends, so that with crutch the whole weight may not exceed 2 lbs. 8 ozs. It was considered that this would make an admirable tool for infantry to carry for shelter-trenches.

APPENDIX No. V.

Weights carried in the Field.

BRITISH.

Articles.	Approximate weights.		Remarks.
	As at present.	As proposed.	
	lbs. oz.	lbs. oz.	
Rifle and bayonet	10 0	10 0	* Made up to 100 rounds, the present French war allowance.
Ammunition	6 0	10 0*	† As proposed by Gen. Eyre's Committee.
Canteen	1 8	1 8	‡ Made up as follows:—
Pack and accoutrements...	10 2	4 3†	lbs. oz.
Field kit	8 0	5 0‡	1 pair of socks.... 0 4½
Clothes on person	11 0	10 0§	1 towel
Water bottle and water ...	2 0	2 0	1 comb
Three days' provision....	6 0	6 0	1 piece soap
Blanket.....	5 0	5 0	1 spoon
Intrenching tool.....		3 0	1 shoebrush
			1 clasp-knife.....
			Thread, needles, &c. 0 0½
			1 flannel shirt 1 1
			1 pair of shoes.... 2 0
Total.....	59 10	56 11	Total.... 4 9½
			§ Deducting chaco.

FRENCH.

Weight of arms and equipment, 1857....	72 lbs.	} As given by Dr. Parkes, ("Practical Hygiene," p. 371.
Or, adding 10 lbs. for clothes on person..	82 "	
In Campaign of Italy, 1859.....	*67¾ "	} As given by Col. Brialmont ("La Fortification Improvisée").
Or, adding 10 lbs., as before	77¾ "	

AUSTRIAN.

Weight of arms and equipment, 1869	49 lbs.†	English.
Adding 10 lbs. for clothes on person	59 "	

* Made up as follows:—

Arms and necessaries	kilo.	lbs. "
60 cartridges	20	41
Tente d'abri, blankets, &c.	2½	5·28
Rations for four days, without meat	5	11
	3·40	7·48
	30·8	67·76

† Made up as follows:—

Kit, including great coat	lbs. oz.
Accoutrements.....	15 3½
Canteen and cooking-tin	10 4½
Provisions	4 0
Rifle { Werndl, with 72 cartridges	3 11
{ Wanzl, with 60 do. 15 lbs. 4 oz.	16 8
Total with Werndl rifle.....	49 11
Ditto with Wanzl do.	48

BELGIAN.

Weight of arms and equipment.....	55 lbs. English.
Adding 10 lbs. for clothes on person, as before	65 „
Of this I have no detail.—G. G.	

APPENDIX No. VI.

Transport of Tools for One Brigade.

Lient. Blood, of the R.E. Train, has kindly supplied me with the accompanying memorandum:—

“For transport of the intrenching tools for one brigade only of the light pattern, one wagon would be sufficient. The tools would be as follows:—

Picks	380
Shovels.....	380
Total.....	760
Spare helves for—	
Picks.....	30
Shovels.....	30

“The detachment of R.E. Train would be as follows:—

N. C. O. mounted.....	1
Drivers	2
Shoeing-smith	1
Sappers	4
Total men	8
Horses—	
Riding	1
Draught.....	4
Total horses ..	5
Wagon	1

“The wagon would require to be specially fitted up, and when loaded would weigh as follows:—

Wagon	14 cwt.
Tools	18 $\frac{3}{4}$ „
Camp equipment, &c.	2 „
Total	34 $\frac{3}{4}$ „

“This would not be too much for four horses; in fact, a properly constructed wagon with this load could go anywhere with infantry.”

“S. M. E.,

“B. BLOOD.

“5th May, 1870.”