THE ROYAL ENGINEERS JOURNAL.

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CONTENTS.

PRICE, C NCE.

Mr.
(T

MILITARY COLLEGE, RICHMOND, SURREY.

(Inspected by the University of London).

MR. H. F. TRIPPEL and MR. SPENCER MITCHELL

PREPARE FOR ALL ARMY EXAMINATIONS AT

Onslow Hall, Richmond Green, & Shrewsbury House, Twickenham Park

Town Branch—

10, Duke Street, St. James's, S.W.

SUCCESSES JANUARY, 1904, TO JANUARY, 1906.

WOOLWICH.

Place.	Name.	Place.	Name.
8th	C. Holland.	43rd	S. M. Noakes.
*15th	H. Smithson.	46th	V. A. H. Taylor.
18th	C. H. Lemmon.	50th	H. G. Worsley.
*19th	W. E. Buckingham.	*56th	B. F. Rhodes.

SANDHURST.

6th	G. H. MacCaw.	32nd	A. E. Saunderson.
11th	A. G. Saulez.	39th	H. A. Studdy.
*15th	G. I. Carmichael.	66th	H. K. D. Evans.
23rd	R. H. Koster.	131st	R. G. Moody-Ward.
*25th	H. F. Slattery.	148th	G. T. Wright.
30th	J. S. Hicks.	151st	D. M. King.
K.I.C.	A. F. Prendergast.		

INDIAN POLICE.

2nd ... ... W. T. Wickham.

ARMY QUALIFYING CERTIFICATES.

Name.	ROYAL ARTILLERY.	Regiment.
F. G. J. Berkeley		The Yorkshire R.G.A.
A. F. A. Hooper		The Duke of Edinburgh's R.G.A.
G. B. Bosanquet		3rd Bn. The Suffolk Regt.
E. L. Salier		4th Bn. Shropshire Light Infantry.
C. K. Apthorpe		4th Bn. South Wales Borderers.

	CAVALRY OR INFANTRY.
W. C. Wilson	6th Bn. Royal Warwickshire Regt.
K. P. Wallis	Royal Monmouthshire R.E.
G. F. Bowes-Lyon	4th Bn. Argyll and Sutherland Highlanders.
G. H. Westbury	3rd Bn. Royal Berkshire Regt.
E. S. Bamford	3rd Bn. Leicestershire Regt.
G. M. Wright	3rd Bn. Royal Munster Fusiliers.
T. H. O. Crawley	7th Bn. Royal Fusiliers.
W. F. Anderson	7th Bn. Royal Fusiliers.
L. F. Hepworth	4th Bn. East Surrey Regt.
W. Grischotti	S.E. of Scotland R.G.A.
S. O. Robinson	5th Bn. Middlesex Regt.
E. F. Robinson	3rd Bn. Shropshire Light Infantry.
*H. H. Clarke	3rd Bn. Royal Welsh Fusiliers.

* Successful under the New Army Regulations.

MILITIA COMPETITIVE.

Place.	Name.	Place.	Name.
3rd University ...	G. K. Archibald.	39th Infantry ...	L. F. Hepworth.
4th University ...	H. Wilson.	49th Infantry ...	W. Grischotti.
6th Infantry ...	G. F. Bowes-Lyon.	51st Infantry ...	J. T. Hibbert.
12th Infantry ...	J. Mallinson.	59th Infantry ..	T. F. V. Forster.
13th Infantry ...	C. K. Apthorpe.	W.I.R.	C. F. Hughes.
18th Infantry ...	S. H. Drummond.	W.I.R.	F. J. Stevens.

PROMOTION.

Over ONE HUNDRED and NINETY OFFICERS were assisted in "C" and "D."

STAFF COLLEGE, AUGUST, 1905.

ONE Officer received a nomination, and SEVEN qualified.

Telegrams—Trippel, Richmond, Surrey. Telephones—72 and 341 P.O. Richmond, and 884 Mayfair.

NOTE.—Mr. Trippel or Mr. Mitchell can be seen at 10, Duke Street, St. James's, S.W., between the hours of two and five.

N.B.—Special Terms for Sons of Officers of the Royal Engineers.

CONTENTS.

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ROYAL ENGINEERS INSTITUTE.

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HIS MAJESTY THE KING, COLONEL-IN-CHIEF.

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*STRATEGY IN RELATION TO COAST DEFENCE.**

By CAPT. E. J. W. SLADE, M.V.O., R.N.

BEFORE discussing the question of the defence of our coasts, we must first of all form some idea of how they can be attacked, and what parts of them are liable to attack. Then we must place the question of defence in its proper relation to the general strategy of the war, for we must be careful not to think of it as a thing apart from the whole scheme of operations. Whatever nation we may be engaged with, the main lines of strategical operations must be worked out as a whole, taking in the operations of all the fighting forces of the crown, and not looking on the two main divisions of them, the Army and Navy, as separate units, which have little or nothing to do with one another and which can act along different lines each more or less independent of the other.

Being an Island Power we hold a different position as regards our frontiers to that held by all other Great Powers with the exception of Japan. An enemy is obliged to cross the sea in order to attack any portion of our frontier, and he is therefore obliged to embark on the element on which we pride ourselves as being the paramount Power. In order to do this he must send an expedition from his coast to ours, and the importance of this expedition varies with the object that he has in view. It may be one of three kinds :—a Raid, a Diversion, or an Invasion.

A *Raid* is an expedition fitted out to damage some portion of our national property and so hamper any movements that we may be contemplating. Good examples of such expeditions are Drake's expedition to destroy the ships fitting out for the Armada, the Dutch raid on the Medway to destroy the shipping and Naval stores, and our expedition to Washington in the American War of 1812.

A raid may be an expedition of any size from a single ship to a force of considerable magnitude, say 10 or 12 thousand men ; but the essential feature is that the objective is merely destruction and not occupation. The object attained, the expedition withdraws, and the operation may or may not be repeated in another quarter.

* *Abstract of Lecture delivered at the Royal Engineers Institute on 22nd February*, 1906.

A *Diversion* is a more serious operation, and is as a rule conducted by a large force. Its object is to divert or draw off a considerable portion of the enemy's forces from the main theatre of operations. Let me take as examples Napoleon's expedition to Egypt, his expedition to the coast of Ireland, his projected expedition to Scotland, and perhaps also, when considered in relation to the main lines of the Napoleonic wars, our Peninsular Campaign.

Lastly we have *Invasion*, which means a very large force, sufficient not only to subdue the main forces of the enemy but to occupy, hold, and administer the territory conquered. We need not go further back in history for an example of this kind of expedition than the war which has just closed.

There are many expeditions in history which are on the border between two kinds, or which pass from one to another according to the opportunities which arise; but there is one characteristic which is fairly constant and that is the degree of importance of the oversea communications. In the first class the expedition is self-contained and the communications are practically *nil*; the expedition is launched out into space, and stands or falls by its own strength. In the second the communications are more serious, and the expedition will probably be accompanied by a much larger fleet of store ships and transports than in the first case; and at the present day it will most probably be dependent on a line of supplies from its own base, at any rate for a portion of the time during which it is acting. In the last case the communications must be continuous, and any interruption of them will entail serious consequences and will most probably lead to the ultimate defeat of the expeditionary forces.

In the days when wind supplied the motive power of our ships the communications of our fleets were not such a matter of vital importance as they are now, as the ships could exist for comparatively long periods without being obliged to have recourse to their base of supply. But now that steam is the only means of propulsion they cannot live without a constant supply of coal, oil, and water, and this fact makes them extremely sensitive to any threat on the line by which these necessaries are supplied. Even in the days of sails communications played a great part in Naval warfare; our abandonment of the Mediterranean in 1799 was brought about solely by the success of Napoleon in dragging Spain into the war against us, and so forcing Jervis to come back to a position off Cape Finisterre where he could cover the line of his communications.

It is said that in land warfare strategy is mainly a question of communications, and the same holds good at sea in the present day. It is therefore evident that the first principle of coast defence is to ensure that the enemy's communications are unsafe.

From this it follows that for a first line of defence in all circum-

stances we must maintain command of the seas that surround our coasts.

The term command of the sea is often used very loosely, and it may be as well to explain what it means.

The command of the sea may be absolute as in the case of our South African war, but that is a state of affairs that will not happen if we are engaged in war with any European Power. It then becomes partial, or perhaps a better word would be potential. It then means that the enemy cannot bring any force to bear on any portion of the area of operations without our being able to concentrate a stronger force on him before he can do much damage. It does not mean that the enemy cannot send any ships to sea, but it does mean that, if they get to sea, they will be dealt with before they can effect much and we hope that they will not get home again.

Now let us apply this reasoning to the question of attack on our own coasts, and see how it affects the situation. We will take the case of invasion first. Since this will require a constant stream of transports to maintain the troops when once they have landed and to supply the fleet that is covering the disembarkation, it follows that it is an impossible operation until the control of the line of communications has passed out of our hands. The operation of disembarking the troops and stores cannot be completed in a few hours and the transports will be liable to attack during the whole time that it is in progress. If we grant the hypothesis that the command of the sea enables us to concentrate a superior force on any hostile body of ships that are attempting to operate against us, then it follows that the hostile fleet itself will be unable to effectively cover the landing and the expedition must end in disaster. Another point is that no such operation could hope to succeed by surprise, as the collection of the necessary troops and transports could not be concealed, and from the suspension of sailings of liners we should have ample warning of its preparation. We probably should not know the exact spot at which it was intended to land, but we ought to be able to deal with the expedition before it reached our shores.

The same applies to the case of a diversion, but in a minor degree. A diversion would necessitate a smaller force, fewer transports, and a less important line of communications. It would probably be directed against an outlying portion of our islands, such as Ireland, where the enemy would hope to get assistance from the disaffected portion of the inhabitants; but the invaders would probably fall a prey to our fleet before they could complete their disembarkation.

A raid is on a different footing. It will be pushed home by evasion of our ships, and it will depend upon the rapidity of its movements and the unexpectedness of the attack to surprise the spot aimed at before adequate arrangements are made for its defence.

The severity of the blow in the case of success will to a great

extent determine the probable objective of such an attack ; and any of our large shipping centres and manufacturing or shipbuilding towns on the coast may expect such a visitation at, or even before, the actual declaration of war. Such places as the Tyne, Barrow-in-Furness, Liverpool, the Clyde, are all liable to attack, those that are most exposed being more liable than those that are more or less protected by their geographical position. Our Naval bases may also be raided if the enemy imagines that we are unprepared to meet him.

A raid may or may not be accompanied by troops, according to the circumstances, but it is improbable that any warships except cruisers will be so employed. It is very easy in the present day to fire away the whole of a ship's ammunition in a very short time, and foreign ships carry much less ammunition per gun than ours do. Imagine the feelings of a foreign Admiral, who had expended a considerable portion of his ammunition in a bombardment of the defences of any of our ports, and then suddenly found himself confronted with a British squadron with full magazines and forced to fight an action of perhaps hours' duration.

A raid might be attempted by troops alone without any naval escort. They would hope to attain their object by surprise ; and would surrender the moment that the destruction aimed at was carried out or the forces brought against them were sufficient to make resistance hopeless. This would perhaps be the most likely form for a raid to take at the beginning of the war, particularly if the enemy was one that could well afford to lose a few thousand men provided they could strike an effective blow at our Sea Power.

The points most vulnerable next after the manufacturing centres, or perhaps equally with them, will be the long-distance wireless telegraph stations. These are Poldhu in Cornwall and the stations being erected in Scotland and Ireland. Of these Poldhu is liable to destruction from bombardment by a single ship, and we may expect the attempt to be made as soon as possible after the commencement of hostilities, if not before. The attempt may or may not be followed by a disembarkation to seize and destroy the instruments, but this ought to be easily dealt with. The other stations are to be placed inland, out of range of guns, and it will be necessary to land in order to injure them.

The means to be taken for our defence can now be more closely considered. Since we are not likely to be called on to face an invasion, large fortified positions in the interior of the country are not necessary ; nor is any elaborate preparation advisable for the concentration of a very large army in the neighbourhood of London.

Similarly defence against a diversion should not take the form of permanent fortifications ; we must trust to the Navy to see that the

operation fails through the destruction of the covering fleet and of the line of communications.

A reasonable amount of defence must be given to those points which offer a bait for a raid, and this defence must be proportioned to the force which is likely to attack. A Naval Base Port, such as Portsmouth, Plymouth, and Chatham, must be provided with such an armament that it would not be worth the risk for any hostile ship to come within the area from which the docks and basins could be bombarded. The distance at which a bombardment can now be carried out is much greater than was formerly conceived to be possible, and we may consider that ships might now attempt to throw shell into a dockyard from a range of anything under 15,000 yards; whether they consider that the damage that they will do is worth the ammunition that they will expend I cannot say, but the possibility is there and it must be faced. The effective range of well-placed heavy guns against ships may also be taken as about 15,000 yards; and therefore it is evident that the placing of batteries in front of the line to be defended, as long as they have a clear range for their guns, may be considered as forming an adequate defence. It is not necessary to have very many of these guns, but there should be sufficient to make the risk to the enemy very considerable. It is then probable that the attempt will never be made, and the mere fact of the presence of these batteries will keep the enemy from trying to find out how strong they are.

The larger and more important Commercial Ports, containing as they do vessels of all sizes, most of them capable of use to the State during war, either as transports for troops, auxiliary cruisers, or storeships or colliers for the Fleet, are all liable to attack. Besides the ships there are also the shipbuilding yards at which war vessels of some sort or another are always under construction, and the destruction of these would mean a severe blow to our Sea Power. It is not at all likely that the enemy's battle-ships will attempt anything of this sort, as it would only expose them to being brought to action by our battle fleet with their own magazines already depleted and their ships perhaps already slightly damaged. Cruisers, either armoured or protected, are the most likely vessels to be used as the covering force for the expedition, and it is therefore necessary to provide an armament that will delay them from carrying out their plans before reinforcements can be brought up by us.

An expedition totally unescorted may also attempt to rush a place, but its ability to do so will depend upon the amount of warning it gives.

The enemy will attempt to land on some part of the coast clear of the fixed defences, and will endeavour to capture the docks and shipbuilding yards by a *coup de main*. This will limit the distance from the point of attack of the site selected for the disembarkation, and it

is therefore only necessary to closely watch a short extent of coast line. Such a disembarkation should never be allowed to take place unopposed, and a very small number of men properly placed, even if only behind hedges and walls, would be quite sufficient to make it a work of very great difficulty and danger. It must be remembered, however, that it will be too late to get the men to their stations, if we wait until the ships are sighted, for under modern conditions it would be quite possible for a covering force to land within an hour of the first appearance of the ships on the horizon. It is obvious that the proper time to deal with all such expeditions is during the period that the men are crowded together in the boats, without cover of any kind and incapable of making any defence, and having probably from ½ to ¾ of a mile of water to cover before they can set foot on the beach and then a further 100 yards or so of very bad ground to get across before they can reach any shelter. The advantage here is all on the side of the defence, for with modern weapons and smokeless powder it would be almost impossible for the attacking party to locate the position of the defenders.

I have not touched on the use of the torpedo boat by night or the submarine by day as a defence against such attacks. Provided they can get to the spot in time, they ought to be able to make certain that the transports and some of the escort, if there is any, should not get away again. They may not be able to prevent a disembarkation, as a submarine, even if she did arrive before the men were landed, would not be able to do more than sink the transport, and if the latter was moored in shallow water no great harm would be done.

The relation of coast defence to the general strategy of the war will of course depend upon the nation with whom we are fighting. If the coasts of the enemy are close to ours and the time required for the transport of an expedition is small, then the amount of cross raiding may be expected to be considerable. If we are fighting by ourselves, without Allies, then the question of coast defence will assume a greater degree of importance than if we had Allies, as the whole efforts of our enemy will be devoted to attempting to strike such blows as may induce us to come to terms. Attempts at diversions may be expected in Ireland, and efforts will be made to injure us in every possible way, and the only defence is to maintain such preponderance at sea that the enemy's efforts will be in vain.

Another form of defence, and in many ways the most efficacious form, is that of counter-attack. For example let me remind you of Pitt's famous "System" in the seven years' war. France was then preparing to invade us, and the plans that were then drawn up were those that were eventually adopted by Napoleon half a century later. Pitt refused to take any active measures for defence of the coasts, even to the extent of refusing to call out the Militia at first. What

he did do was to collect an army of about 10,000 men in the Isle of Wight and threaten the French coast; this was sufficient to stop all attempts at oversea operations, and the effect, as described by a French historian, was that every general, the whole length of the coast, saw himself threatened and called loudly for reinforcements.

I have not touched on Colonial coast defence, but this in its main features is governed by the same principles as the defence of the coasts of these Islands. There is, however, one great difference in the character of the lines of communication. On land we look on the lines of communication as running in opposite directions from the respective bases to the front, the outer end of each terminating at the fighting line. At sea this is different. In the majority of cases the lines of communication are parallel, and generally identical; so that any attack on the communications of the enemy, instead of exposing our own line, as often happens on land, ensures its safety. This peculiarity is a most important one, and it is one that is not always recognised. It will enable us to nip in the bud any attempt on our Colonies, and it will at the same time keep our own communications free from all danger of serious interference. But this does not provide for the possibilities of raids by isolated cruisers with the object of doing damage, and therefore we are obliged to provide certain fixed defences in order to protect the vital points.

There is one point I should like to bring before you, and that is the importance of providing a certain measure of fixed defences, not necessarily as a protection against the enemy, but as protection against ourselves. We have a population that is ignorant of all the principles of the art of war, and which is democratic and accustomed to make itself heard and felt. If 'the man in the street' imagines he is in danger, he will bring pressure to bear on the Government to provide what *he* considers necessary for his safety; and no government will be strong enough to resist the demand, although it may know perfectly well that the fears are without foundation. We have only to look at the Spanish-American War to see what the effect may be. The strategical arrangements on both sides were largely upset because the idea got about that each was going to attack the home coasts of the other. The American towns on the Atlantic coast took alarm when Cervera sailed from Cadiz, and forced the Government to form what was called the Flying Squadron. This in its turn reacted on the Spaniards, principally on account of the name, and prevented them from sending out a sufficient force to enable Cervera to do his work. Here is an instance of what Clausewitz calls the 'Friction of War'; and although such nervousness has no real foundation, it is nevertheless a fact which must be taken into consideration. However much we may deplore the constant interference of ill-informed and ignorant people with the plans of professional strategists, we cannot ignore them; and it is as much part of

the Art of Strategy to foresee the objections likely to be raised and to forestall them, as it is to divine the enemy's movements under all possible circumstances.

Let me now sum up the principles that I have endeavoured to put before you.

The general strategy of a war is determined in its main lines by the object of the war. On this will depend whether our main efforts are directed against the coasts of the enemy or whether we attempt to bring pressure to bear on him by attacking his foreign possessions first. In the first case we shall have the whole of our forces concentrated on the portion of the sea immediately facing his coasts and military harbours, and the opportunities that he will have for sending out any expedition will be very small. Coast defence will then occupy but a small place in our plans, as even raids will be difficult to carry out. If, on the other hand, a large portion of our forces are occupied elsewhere, the enemy's opportunities will be correspondingly greater, and we may expect that he will attempt to take advantage of them to force us to desist from the operations that we have undertaken.

There is always this point to be borne in mind,—cruisers and battle-ships cannot be in two places at once, and cannot be doing more than one thing at the same time. If they are occupied in watching our ships and in protecting their own coasts, they cannot be used to convoy expeditions to attack ours. If the enemy wishes to use his fleet against our fleet, he will require all his cruisers for scouting and reconnaissance work and his battle-ships will all be required to strengthen his line of battle sufficiently to stand against the fleet that he will expect to meet; he will therefore have none to spare for other purposes. If, on the other hand, he decides to keep his battle-ships behind his forts, then he may be expected to use his cruisers to raid either our commerce or our coasts. Of the two alternatives it is probable that he will choose the least dangerous and will devote his attention to the commerce, but we must be prepared to find him attempting anything that offers a reasonable chance of success.

It is therefore evident that the relative importance of coast defence will vary with the general strategy of the war. We must be careful always to bear this in mind, or else we shall find ourselves underestimating or over-estimating its value and either risking too much or losing opportunities through excess of caution.

Firstly, the command of the sea must never pass from our hands. This means the control of the lines of communication.

Secondly, if we have the control of the lines of communication, then no expedition of any size can be safely despatched against us.

Thirdly, raids cannot be prevented, as they may evade the watching cruisers and they have no communications to be cut. To deal with

raids sufficient fixed defences are required to delay them until reinforcements can come up to deal with them. The value of the bait offered will determine the localities to be defended, and the probable nature of the attack the amount of defence to be provided.

Fourthly, the value of the counter-attack, and the general relation of the whole scheme of defence to the strategical requirements of the war.

Fifthly, the importance of keeping the nerves of 'the man in the street' in good order.

THE RÔLE OF ENGINEERS ON THE FIELD OF BATTLE.

By Col. S. A. E. Hickson, D.S.O., R.E.

Undoubtedly amongst the more important lessons taught by each succeeding big war of modern times is the increased importance of the military Engineer in all the operations of war, and, above all, of the Engineers as a combatant unit in the attack, as well as in the defence, of a position in their *rôle* as the fourth arm of the Service.

It is not the Artillery alone that must now prepare the way for the Infantry assault.* It is the sapper who, as often as not, must not merely accompany the firing line, but precede it. It is he who, with wire-cutter, saw, and axe, must clear the way for the men with the rifle, and discover and remove those mines, entanglements, and other obstacles which the defender will invariably spread to detain his enemy under the fire of his works. In some cases the Engineers of the defence will have made positions so strong that a frontal assault is impossible, as occurred to ourselves at Magersfontein and Colenso and to the Japanese at Shou-shan-pou in their advance on Liao-yang. Then a flank or enveloping attack becomes a necessity. On other occasions, if it appears that a frontal attack, perhaps by night, can succeed at all, it is to the Engineers it falls to lead the attempt, as occurred to ourselves successfully by sap and spade at Paardeburg, and as was attempted by the Japanese, when, with wire-cutters and tools,

* The following interesting extract of observations by Lieut.-Colonel Masahito Kasoi Mura, of the Japanese General Staff, Tokio, appears in the *Journal of the Royal United Service Institution* for February, 1906:—

"In our methods of attack we believe we have advanced a little beyond European methods by the application of field fortification to the attack. This does not serve us for defence, but assures us a point of rest during the forward movement. On the skirmish, or firing line, one fires while the other digs—a rifleman is immediately followed by a sapper. We work in a manner distinct from that of other armies. Our agile soldiers dig while lying down. They offer no target to the enemy, and excavate without being seen in the most advanced positions; the succeeding files find a shelter already made. Since these fortifications exist at each stage of the attack, we can dispense with strong reserves. In Germany for an attack only the reserves fortify; work with spade is only done at night when men can work standing, and only as an auxiliary means of defence. As we dig while lying down, we can entrench ourselves during the daytime, and an enemy attacking our front, although he may be superior to us, can do nothing to us without artillery."

their Engineers endeavoured to clear a road through the Russian mines and wire entanglements, etc., in the attack on Nan-shan and also in the attack before Liao-yang, notably at Middle hill and Rocky ridge.

It is not then only when an army is shifting its base along the shore that detachments of Engineers must be sent ahead with the covering force to prepare landing stages and rafts. It is no longer only on the march that detachments of Engineers must accompany the advanced guard to prepare the roads and bridges, perhaps under fire, before the other arms can advance. It is not only in the defence of a position that the Engineer must be first on the spot, to devise, plan, and lay out cover and shelter trenches, cunningly conceal them from the enemy's view, and by artifice and ruse seek in every way to co-operate with the other arms, both by deceiving the enemy as to the defenders' real position, and by means of obstacles delaying or altogether preventing his advance. Nor is it only in the siege that the sapper must lead the forlorn hope, and fix the charge, which is to blow not only the enemy but himself to glory, provided he be not, unfortunately, shot down before he can accomplish his self-sacrificing duty. But above and besides all these functions—since every considerable action under modern conditions tends to assume the form of a miniature siege—in every attack even more than in the defence, it is now by the combined action of the Engineer co-operating with the Infantry soldier, under the sheltering fire of the Artillery, the one removing obstacles, the other covering his work by fire, that victory in the assault must in the future be sought.

In almost every serious frontal attack on a defended position it now becomes necessary to tell off with the covering force, to every extended company of Infantry in the firing line, a section or squad of Engineers, not merely to act as ground scouts, but to work with unflinching determination under the enemy's fire without even the moral satisfaction of returning it. Their essential function is as rapidly as possible to discover and remove every species of obstacle put in the way of the advancing Infantry, and to improve for the use of the attacking force any natural or artificial cover they find. Man after man may often have to nobly sacrifice himself, and for many an hour will the attacking line have to wait under a galling fire whilst these operations are on foot; but the greater the skill of the Engineer in performing them, and the greater his daring, the greater chance will there be for the final assault of the Infantry on the enemy's trenches.

The immense size of modern armies, and the immense range of modern arms,—as has now so often been proved—makes the fronts that the defender can protect, and the distances over which the assailants must march, so great that time is given to enable the defence to make the most formidable works and obstacles. The front of the

Japanese army from Hai-cheng on their left to Mo-tien-ling on their right extended over nearly fifty miles. When at last the position taken up by the Russians before Liao-yang was reached, it was found to bristle with defence works, strongly made and artfully concealed, with mines, entanglements, and other obstacles spread along every possible line of approach. It fell to the Engineers of the attack to clear the way for the assaults—so often unsuccessful—on the strong positions thus prepared by the defenders. These attacks were sometimes made by day, but more often commenced by night and continued during the day. They were moreover often made under urgent orders that the positions must be taken at all costs, and the sacrifice of life was very heavy.

Such, briefly outlined, are the conditions of the attack on artificially-defended positions, as developed during the latest war from the Engineer's point of view. The absence, therefore, of any distinct *rôle* for the Engineers in our latest treatise on "Combined Training" is to be regretted. It is stated indeed in Sec. 122, Chap. VI., that, "if possible, parties of Engineers should always be within reach of troops attacking"; but this is the only allusion to their duties, and, if this is considered their *rôle* in the attack, it is not clear why it is not stated to be so in paras. 2 and 3 of Sec. 103, Chap. VI., where the functions of the other arms are briefly sketched. In para. 3, although the necessity for entrenching is elsewhere proclaimed, it is not laid down that all officers should gain some knowledge of engineering and make themselves acquainted with the principles which govern the employment of field defences. Nor is it even laid down that planning such defences and making obstacles is the special province of the Engineer. In fact from much of the chapter on attack the novice might be led to conclude that the enemy's fire is the only obstacle to attack, and that but for this Cavalry and Mounted Infantry could trot about unimpeded all over the field up to the very trenches of the enemy. Again in Sec. 105, Chap. VI., the intelligent use of ground is said to be the first condition for the attainment of superiority of fire; but how far this is the speciality of the Engineer, at a time when the other arms have their minds full, is not indicated. Throughout the chapter dealing with the attack and defence—although the importance of seizing and strengthening localities and of preliminary operations, such as the passage of a river and the preparation by the Artillery for the advance of the Infantry, are mentioned,—no distinctive *rôle* is laid down for the Engineers such as modern war might, from what has been written, be expected to require. Yet if, as already said, it is the Artillery who should prepare and cover the Infantry advance, it is the Engineers who must make the final assault possible; and it is they who, co-operating with the Infantry, must, under the protection of the Artillery fire, clear away the enemy's obstacles and mines.

The omission in our latest treatise on Combined Training to assign

any specific *rôle* to the Engineers, more especially in the attack, seems all the more remarkable when it is considered how much has been said and written of the lessons of the late war in the Far East. It is possible that, in compiling this treatise, a fear existed that, if the duty of entrenching, leading, and clearing away obstacles were dealt with as the special *rôle* of the Engineers, the Infantry would incline to abstain from spade work and hang back; or that there was some revival of the old idea that all branches of the service should be able to do the work of the sapper as efficiently as himself. There seems however to be no good reason at all to fear that the Infantry soldier, if provided with tools, will not dig himself in as hard as he can for his own safety and protection—even though such duties as entrenching, mines, and the removal of obstacles are especially the *rôle* of the Engineer—just as readily as the Engineer will on occasion use his rifle, though the spade or wire-cutter be his first duty. It seems desirable therefore that this specific *rôle* of the Engineer should be discussed, and the duty of each arm in mutually supporting the other be more closely defined from the point of view of the Engineers, as well as of the Artillery, Infantry, and Cavalry. It is by the co-operation of all units that victory is to be sought.

In this respect—that is from an Engineer point of view—three deductions stand out clearly as the guiding issues of recent experience in war:—

(1). That detachments of Engineers should accompany or precede every covering party of Infantry in the firing line.

(2). That a large proportion of Infantry, not less than half, should carry tools into action and use them.

(3). That entrenching by night must be frequently resorted to, and should be assiduously studied and practised in time of peace.

The relative duties in entrenching, as between Engineer and Infantry soldier, may hence be very easily deduced. The Engineer is to be the skilled scout and guide through obstacles, the student and indicator of sites and designs, forms and sections of work, the defence of villages, etc.,—the professional adviser; the Infantry and others to lend a hand, as far as lies in their power, in the construction of works, when not required for their own more particular *rôle* as riflemen.

As the horse distinguishes the Cavalry, and the gun the Artillery, so the spade distinguishes the Engineer from the Infantry. And as Cavalry, Artillery, Engineers, and Infantry, all on occasion use the rifle, so should each, to some extent, be able to use a spade, manage a horse, or handle a gun. It is, at least, by each thoroughly understanding the *rôle* of the other that perfection in the co-operation of all is to be sought.

Some explanation of the reason for overlooking the special *rôle* of the Engineer as an arm of the Service on the field of battle may perhaps be found in the fact that the occupation of our own Engineers in time of peace has hitherto been so closely associated with the building of barracks that the rest of the Army has failed to recognise that they have any specific *rôle* on the battle-field. It is high time, if we would be up-to-date, that this old idea passed away. The construction of works in time of peace no doubt still is, and always has been, considered the best training the military Engineer can get for many of the operations of war in which he has to co-operate, over and above his duties on the battle-field. Such, for example, are bridges, roads, railways, and telegraphs, all of which may be described as his strategical functions, in distinction from his tactical or more exclusively military functions. It is, however, the ever-growing importance of these tactical functions of the Engineer which has so enormously increased, and must and should ever force itself on our close attention. Some way has already been made by reducing the time spent on what may be called the trade of the house-builder, painter and decorator rather than of the Engineer. It is this form of engineering which is of least use to the military engineer in time of war; but nothing will be gained by giving this up, if the tactical *rôle* of the Engineer in co-operation with the other arms is not practised.

That the importance of this tactical *rôle* has enormously increased is nowhere denied; and it is hardly too much to say that, at the present time, a company or troop of Engineers should be associated with every Infantry or Cavalry Brigade, and should be constantly trained with it.

Our official treatise on Combined Training, in addition to omitting to assign to the Engineers any special *rôle* on the battle-field, appears to lay insufficient stress on 'co-operation' generally. In the first line of Chapter VI. on attack and defence, the significance of the co-operation of all arms, though each "possesses a power peculiar to itself," is indeed indicated; but it seems strange, in the face of such an announcement, that the peculiar power of the Engineers (*i.e.*, science and the spade) is not referred to, whereas the *rôle* of the Cavalry, whose peculiar power in modern tactics lies in his horse and speed, is fully considered. Although the expression 'operations' occurs frequently throughout the treatise, the term 'co-operation' gives way almost invariably to 'combination.' It may be that this term 'combination' has occasionally a special and useful application, as implying tactical skill on the part of the supposed leader or commander to make use of the several arms at his disposal. Speaking generally, however, reflection shows that the term 'combination' carries as a rule a much more narrow and exclusive meaning than the word 'co-operation.' We speak, for example, of Trade Combines or

Combinations, of Combinations of Workmen, and Combinations of Masters, for a special and somewhat narrow purpose. The object, however, of organisation, strategy, tactics, and discipline is the 'co-operation' of all arms and branches of the Service with one will to attain the great national end in view, that is victory. It seems unfortunate that the combinations of the Services should be dealt with in too purely a mechanical sense, when it is possible to put a little spirit into the instructions concerning them.

*No. I COMPANY, Ist (BENGAL) SAPPERS AND MINERS, IN KULU, 1905.**

By Capt. J. Charteris, R.E.

The earthquake which occurred in April, 1905, caused a large amount of damage to the Simla-Sultanpur road and to the local roads in the Kulu District.

The principal damages were the destruction of the Duff-Dunbar Bridge, a structure erected at a cost of Rs.125,000 in 1885, and a very extensive landslip at Burwah, which destroyed about a mile of road and buried the bridge by which the road from Simla crossed at this point from the left to the right bank of the Thirtan River.

At the time of the earthquake, No. 1 Company had been detailed to work on the Hindustan-Thibet Road. But, at the request of the Chief Engineer, Public Works Department, Punjab, their destination was changed to Kulu, and all preparations were made for the Company to proceed there in May. Considerable delay occurred in arranging the terms of employment, and consequently the departure was deferred until the 16th June, by which date the terms had been laid down by the Military Department and accepted by the Civil Government of the Punjab.

The terms finally settled were briefly as follows:—

The Civil Government to pay:—(1) ¾ rates of working pay to N.C.O.s and Sappers when on the march to and from the site of work, and for days between the date of departure from and the date of arrival at Roorkee on which the men were not employed on work.

(2). Full working pay for days on which the men were employed on works to N.C.O.s and Sappers, and throughout to Native Officers, and full engineer pay to British N.C.O.s.

(3). Compensation for dearness of provisions, extra warm clothing, hutting, conservancy and water supply charges, tools, etc. required for the work; and the cost of all fair wear and tear to the Company equipment.

These terms were, I think, very fair, and proved very satisfactory both to the employer and the employed. As will be seen from the statement of accounts attached, the only charges made against the Civil Government on account of para. 3 of the terms of employment were for compensation for dearness of provisions and Rs.4-13-11 per man for clothing. These charges and the full rates of working pay

* Communicated by the Commandant, 1st Sappers and Miners.

gave the men a slight pecuniary advantage from the work. On the other hand the work done was completed at a much smaller cost than that which the P.W.D. would have had to bear if the work had been done by civil labour under the conditions prevailing in Kulu at the time.

The terms, however, threw upon the O.C. of the Company the task of arranging for his own transport for the march and for the rations of the Company during its stay in Kulu; and as the earthquake, by destroying practically all the houses in Kulu in which the supplies were stored, had produced a state of famine in the country, the latter task involved a considerable amount of work. Rations had to be collected from districts which had been less severely affected by the earthquake, over country tracks the difficulties of which, at all times considerable, had been greatly increased by the innumerable landslips.

It was eventually decided to take from Simla one month's supply for the men, and to trust to local supplies for the rations of the equipment mules and the 204 country mules which formed the transport of the Company on the march.

The O.C. of the Company, Capt. Charteris, R.E., proceeded on the 10th of June to Simla to arrange for transport and the month's supply of rations, and the Company under the charge of a Native Officer joined him there on the 16th June. Lieut. H. J. Elles, Company Officer, was on special duty at Delhi; and as the Corps was under its establishment in British Officers, no other British Officer could be spared from headquarters at Roorkee.

The Civil Authorities had requested that the Company should first attempt to salvage the Duff-Dunbar Bridge. As the direct road to this over the Jalori Pass was reported to be impracticable, the Company proceeded *viâ* Suket and Mandi, and by making double marches throughout reached the site of work on the 26th June.

SALVAGE OF THE DUFF-DUNBAR BRIDGE.

The bridge which had been destroyed was a suspension bridge of 305-ft. span; the up and down-stream cables were each formed of four 9-in. steel wire ropes; the piers were stone in lime pillars, each 15 ft. by 9 ft. in cross section, and connected by a brick in lime arch over the roadway. The upper and lower booms in the girder were of 12 in. by 12 in. timber; and the roadway weighed 600 lbs. per foot-run of the bridge.

Fracture had taken place in the piers immediately below the arch. The masonry above on both banks had fallen forward into the river bed and the cables had dropped transversely across the roadway; thus the up-stream cable was lying up stream of the remains of the pier on the right bank and in the road between the piers on the left bank, and the down-stream cable in a corresponding position.

The anchorages had not been damaged. The superstructure of the bridge was lying in the river and still secured by the slings to the cables.

There is no doubt that the destruction of the bridge was due to bad masonry in the piers. The mortar used had disintegrated and gave off clouds of dust from the remains of the pier at the least breath of wind; the inside of the piers, as far as could be judged, had been made from the remains of boulders from the river bed thrown into a bed of mortar; there was no bonding.

Before the arrival of the Company, the local Sub-Division Officer, P.W.D., had attempted to raise the cables by wedging logs underneath them. The Company commenced work on the 28th June. The method adopted was to raise one 9-in. rope at the pier by means of screw jacks to a height of one foot above the 9-in. ropes of the cable of which it formed part, and then to pull sheers underneath the rope as far out in the river as the men could work, and then sever the clips which secured this rope to the remainder of the cable; the jacking was then continued as far as the jack would lift the cable, and the process continued.

A traveller on a 3-in. wire rope was put across the river to enable work to be carried on on both banks; and as the cable appeared it was secured by differential tackle to this rope, and at the same time was secured up stream by a 3-in. wire rope.

By the 7th July, one 9-in. rope had been raised on to scaffolding 17 ft. high on the right bank and 12 ft. high on the left bank, and men working on the cable in the water had been able to sever all the clips; a 3-in. steel wire rope was then secured by clips and taken over sheers to a winch, and the 9-in. wire rope was pulled clear of the water. With one 9-in. wire rope secured above the water the remainder of the wire ropes of the cable presented no difficulty. Each was jacked up separately to the top of the scaffolding and then drawn out of the water.

In the meantime sanction had been applied for to erect a new and lighter bridge across the river. As only four 9-in. wire ropes were required for this, it was decided to cast the down-stream cable loose on the left bank and endeavour to draw the loose ends across to the right bank. After the up-stream cable had been raised a large amount of the roadway had been broken apart from the down-stream cable by a heavy flood, and from the flow of the river it was estimated that not more than 160 ft. of roadway remained attached to the down-stream cable. This estimate subsequently proved too small.

A calculated weight of 12 tons of wood, which it was estimated would suffice to float the end of the cable and by the force of the water keep it fairly taut and prevent it fouling the rocks in the river bed, was securely wired to the cable close to the anchorage. A 3-in.

steel wire hawser was secured to this float, and was taken across the river to a winch which had been put up at a distance equal to the span down stream of the pier on the right bank. On casting loose from the anchorage the wooden float came across to about three-quarters of the distance, but at this point the cable fouled some large rocks and the pressure of the water caused the float to sink. Eventually the cable had to be overhauled from the right bank and men were sent out on rafts to lift it by grapnels over the rocks on which it had fouled. It would have been an advantage to have secured light buoys with long lines to the cable at intervals before casting loose, to enable the place where it fouled to be judged.

BHUNTAR TEMPORARY BRIDGE.

On the 26th July, on the day that the salvage work was completed, sanction was received to construct the temporary bridge. On the same day a party of men was sent to cut the necessary trees for the woodwork, and the iron work was commenced. The bridge was opened to traffic on the 12th August, and completed on the 19th August. The work was delayed by the small quantity of blacksmith's tools available. The P.W.D. were unable to provide any; and as every bolt and nut had to be threaded by the two boxes of stocks and dies in the equipment of the Company, and as every spike and dog had to be made up out of the raw iron, the blacksmiths could not turn out the iron work as quickly as it was required, although they were kept at work 12 hours each day including Sundays. Had it been possible to purchase bolts, nuts, dogs, and spikes, I think the bridge would have been completed in 8 working days. It is to be remembered, however, that the time taken does not represent the erection of the bridge only, but also the felling of the trees required for the woodwork and their transport from the forest to the site, a distance of 2½ miles over very rough ground, the sawing of the chesses, etc.; and that, owing to one section of the Company being detailed for other work and a detachment having been left at headquarters at Roorkee, not more than a half Company was actually available for this work.

Plate I. shows the bridge erected. It is worth noting that the bridge was extremely stiff. This I attribute to the very slight dip (1 in 20) and to the large horizontal splay given to the cables (from 14 ft. over the piers to 7 ft. at the centre).

DAMAN TEMPORARY BRIDGE.

On the 17th July, one section under a N.O. and the senior British N.C.O. of the Company, was detached to assist the P.W.D. in the erection of a bridge at Daman, 19 miles distant, to replace the bridge at Burwah which had been destroyed by the earthquake. The

original idea for the bridge to be constructed was a cantilever bridge from dry stone masonry piers across a span of 90 ft. with two small spans of 20 ft. each on the shore side of either pier. Both the design and the site were the choice of the P.W.D. The piers were designed to be 32 ft. above foundation level, a dangerous height at which to put the strain of the cantilevers on a dry stone masonry pier; and the pier on the left bank was, owing to a sharp bend in the river immediately above the bridge, precisely in the fairway of any trees brought down the river when swollen by flood. For these reasons the design did not appear to be suitable; but as orders had been given work was commenced, and by 10th August the piers on the right and left bank had been raised to a height of 16 ft. 6 in. and 5 ft. respectively, with a cross section of 18 ft. by 15 ft. and a cut water up stream.

On the 11th August, heavy rains brought down a 14-ft. flood; and on the 12th, when the flood subsided, no vestige of either pier remained. As a small temporary bridge, which was the only means of crossing the river, had also been destroyed, work was commenced without reference on a new site with a span of 140 ft. As the 3-in. wire cables which had been used in the salvage work at the Duff-Dunbar Bridge were now available, it was decided to make a combined suspension, tension, and cantilever bridge (*Plate* II.). The bridge was completed on 7th September; drawings of this bridge are attached.

The ropes available for the cables were 3-in. steel wire ropes with hemp cores. Great difficulty was experienced in adjusting the dip, owing to the stretching of the ropes. The cables were first placed at a dip of 2 ft. 6 in. above the required dip, and the roadway temporarily placed in position. During 24 hours the cables stretched sufficiently to lower the centre transom 6 in. below the required dip. The roadway was taken up and the cables pulled through a further 9-in. dip, but again stretched. Eventually, after four adjustments, the roadway was made to the correct dip, but the bridge will undoubtedly distort under traffic and will not be satisfactory.

REMARKS ON SUSPENSION BRIDGES.

The only points of interest that have come to notice in the bridging work are:—

(i.). The unsuitability of hemp core steel wire ropes for cables in suspension bridges.

(ii.). The extra stiffness that is obtained by giving a deep horizontal splay to the cables.

(iii.). The advantage of passing the roadway over the cables at the centre, both from the point of view of simplicity and hence rapidity of construction and from that of stiffness.

With reference to this latter point a certain amount of waterway is lost at the centre, but I do not think this is of importance. In almost all sites for bridges in the hills the flow of water sets either towards one bank or the other, and logs and trees brought down by floods seldom take their course in the middle of the waterway.

If round iron is available it is, I think, much more suitable for slings than wire rope. It does not stretch, calculated lengths can be laid off exactly, and any subsequent adjustment can be easily made by a screw thread.

REMARKS ON COMPANY EQUIPMENT AND STRENGTH.

With reference to the equipment of the Company the following points came to notice :—

(i.). The metal blocks are unsuitable for working a 3-in. wire rope or a new 3-in. manilla rope.

(ii.). There is no ratchet plant for boring holes in metal ; this has to be improvised, and time is lost.

(iii.). The compound-lever wire cutters broke in the course of one day's work cutting ordinary telegraph wire.

(iv.). The mason's hammers are too light for stone work.

(v.). The books carried in the survey boxes are unsuitable. A Molesworth, an R.E. Field Service Pocket Book, and a Trautwine should be substituted for the Chambers' Tables and the Auxiliary Tables. I would also recommend the substitution of an Abney's pocket level for the De Lisle level.

(vi.). Some means of reproducing plans would effect a great saving of time to the Officers in departmental work. Generally six or seven copies of each design are required, including those to be submitted to the Department concerned, those kept for record, and working drawings.

Throughout the whole of the work, the Company was severely handicapped by the absence of the Subaltern Officer. I am strongly of opinion that no Company should be sent on detached work at any distance from headquarters without its full peace complement of Officers. On such work the Company is almost invariably split up, and the detachments are generally at such a distance that it is impossible to visit all their work in the same day. In addition to the supervision of engineering work there is almost always the extra duty of arranging for rations, a very largely increased correspondence, and dealings with other departments, which the O.C. Company cannot leave to any British N.C.O. The economical employment of Sapper Companies on public works is only effected by very close supervision

and by the general arrangements, in which no N.O. or British N.C.O. can replace an Officer; and it is, I think, very essential that there should be some one ready to take the place of the O.C. Company should he be incapacitated from work.

REMARKS ON EMPLOYMENT OF SAPPER COMPANIES ON PUBLIC WORKS.

With regard to the general question of the employment of Sapper Companies on public work, it will not, I think, be found an economy for a department to employ a Company in preference to local labour on road work, except in places where much rock work is required; in ordinary hill road making, the supervision which the organisation of a Sapper Company enables it to exert is not required, and the cost of the supervising establishment is not repaid by its work.

In bridge making, and in places where labour has to be imported and rations arranged for by the employing department, Sapper labour will usually be an economy. In any work on which a Sapper Company is employed, it will be found an economy to give the O.C. a free hand regarding the employment of any civil labour he can procure. There is in every work a large amount of unskilled labour which can be done cheaper by coolies than by Sappers. The organisation of a Sapper Company is devised for field service, and a considerable number of trades are necessarily represented in its small establishment. The proportion of the tradesmen is arranged to meet the contingencies of field service, with the result that in any work the number of men of some one trade will be found too small. To make good this deficiency it is cheaper to employ civil labour than to have nearly the whole Company standing by waiting while the tradesmen of that trade overtake the work of the rest of the Company.

With reference to the question of terms of employment, the existing rules regarding contract work, whereby the O.C. Company has to pay the cost of moving the Company to and from the site of work and all incidental charges, are detrimental to the chances of Companies taking up contracts at any distance from their station. The O.C. has naturally to protect his men. The contract offered to him must necessarily often be for work at a place of whose local conditions he is entirely ignorant. He has to make a guess at the probable cost of transport of rations from wherever they may be obtainable to his camp (possibly even at the initial cost of the rations); also a guess at the nature of the ground on which his work is to be; and an estimate of the time it will take him to complete his contract, and the consequent saving per month he must effect to cover the transport of his Company to and from the work. When to this he has added a large margin to cover possible contingencies, he will not often find himself in a position to accept a contract.

It is, of course, unreasonable to expect departmental authorities to ask for a Sapper Company, of both the capabilities and cost of which they are probably ignorant, on any other terms than contract terms, until all other means have failed. I would suggest that the military authorities should pay the compensation for rations and the cost of transport; and that the Company should refund to the military authorities the difference between the amount earned by their contract and the full rates of working pay, provided the former is the greater of these sums, up to a limit of the cost of transport.

The risk then lies with the military authorities; and as there is no doubt that a month on works is better training for both officers and men than a year in cantonments, it is fair that the military authorities should be liable to a proportion of the cost involved. But as during the time of the employment of the Company its working pay is not a charge on the military estimates, it would rarely happen that they would be losers by a Company proceeding on contract work on these terms.

The following Table shows the expenditure involved in the various works executed by the Company and in the move to and from Kulu:—

ABSTRACT OF ACCOUNTS OF WORK IN KULU.

Item.	Salvage Work.	New Bridge Bhuntar.	New Bridge, Daman.	Road Work Daman.	Move to Kulu.	Move from Kulu.	Miscellaneous.	Remarks.
	R. A. P.	R. A. P.	R. A. P.	R. A. P.	R. A. P.	R. A. P.	R. A. P.	
Working Pay—								
June	—	—	8 0 3	—	391 15 6	—	—	
July	1,018 11 6	—	—	—	—	—	—	
August	—	424 7 9	594 0 9	—	—	—	—	
September	—	—	124 5 0	151 13 6	—	398 8 6	—	
Compensation for Provisions—								
June	—	—	—	—	123 2 4	—	—	
July	235 6 0	—	—	—	—	—	—	
August	—	105 15 8	58 5 2	—	—	—	—	
September	—	—	—	51 9 10	—	154 13 7	—	
Transport Charges	154 12 0	2 1 0	340 5 9	1 9 0	1,859 3 0	2,351 12 6*	—	* Estimate.
Purchase of Stores	476 1 3	303 13 3	621 12 0	—	—	—	—	
Local Labour	555 10 6	395 9 0	345 10 6	—	—	—	753 4 6†	† A.R. paid for Ex. En.
Repair Camp Equipment	—	—	—	—	—	—	5 1 0	
Repair Equipment	—	—	—	—	—	—	0 2 0	
Military Allowances	100 8 0	38 13 3	91 12 9	12 8 0	46 8 0	48 15 6	—	
Telegrams	72 8 0	—	82 12 0	—	—	18 3 0	—	
Travelling Allowances	—	—	95 3 8	—	26 0 0	4 8 1	—	
Supervising Allowance	72 0 0	38 0 0	24 0 0	20 0 0	—	—	—	
Miscellaneous	—	—	—	—	7 10 6	—	786 7 6‡	‡ Clothing Compensation.
Medical Stores	—	14 12 10	12 2 7	—	—	7 10 10	56 4 0	
Total	2,685 9 3	1,323 8 9	2,398 6 5	237 8 4	2,454 7 4	2,984 8 0	1,601 3 0	

N.B.—Transport Charges of move do not include Railway Charges, which are adjusted by book transaction between the departments.

Cost of repairs and renewals to Engineer Equipment is not included, as this charge is also met by book transaction.

The cost of the Daman Bridge is high, owing to the large amount of masonry in the abutment. A suspension bridge of larger span would have been cheaper, had cables been available.

EFFECT OF MAGNETISED FORAGE CAPS ON PRISMATIC COMPASSES.

By Capt. F. M. Close, R.E.

Having occasion to do some prismatic compass sketching in Bermuda, I found the magnetic declination as observed by me to be very different to what was expected. I traced the discrepancy to the iron wire which stiffens the rim of my forage cap. For purposes of check I took a round of angles with Lieut. A. L. Owen, R.E., the results of which are appended.

It will be seen that a prismatic compass sketch could not possibly be carried out with any reasonable accuracy by an officer wearing a cap in a condition similar to mine; and my experience may be useful to others.

No doubt both Lieut. Owen's cap and mine have become magnetised owing to our constant work in dynamo rooms, for no appreciable error was discovered in tests with new caps out of the clothing store; and evidently only caps that have been near dynamos or other electric light gear are sufficiently magnetised to matter.

I submit that no stiffening wire should be allowed in these caps, or that, if allowed, the wire should be non-magnetic, such as copper or brass. This of course applies specially to R.E. officers.

ERRORS INTRODUCED IN PRISMATIC COMPASS BEARINGS

BY WEARING FORAGE CAPS STIFFENED WITH STEEL WIRE RIMS WHICH HAVE BECOME MAGNETISED DURING E.L. PRACTICE.

Object.	Bearing taken by Lieut. Owen, R.E.		Bearing taken by Capt. Close, R.E.		Error with Cap on. Lieut. Owen.	Error with Cap on. Capt. Close.	Remarks.
	Cap on.	Cap off.	Cap on.	Cap off.			
1. Door of Oil Store...	344°	360°	5½°	359½°	16° W	6° E	Both caps have rim wires strongly magnetised, due to officers being employed on E.L. duties. Two poles in Capt. Close's cap; four in Lieut. Owen's.
2. Flagstaff	61°	48½°	49°	47½°	11½° E	1½° E	
3. Telegraph Post.....	99½°	90½°	84½°	90½°	9° E	6° W	
4. Edge of House	140°	144½°	135°	145°	4½° W	10° W	
5. End of Gunshed ...	166½°	181°	173½°	181°	14½° W	6½° W	
6. Gable of Church ...	194½°	208½°	207°	209°	14° W	2° W	
7. Chimney, Mt. Eric	234°	246½°	252°	247½°	12½° W	4½° E	
8. Scaffold Pole	316°	311½°	323°	311°	4½° E	12° E	
9. Rain Water Pipe ...	327°	327°	340°	327°	0°	13° E	

THE DIRECT CURRENT 3-WIRE SYSTEM.

By MAJOR F. BAYLAY, R.E.

THE results recorded below refer to a series of observations made at the Electrical School, S.M.E., upon an experimental circuit arranged to represent a D.C. 3-wire system, having one main generator across the "outers" and one electrically driven "balancer."

It may be desirable to remark that a D.C. balancer consists of two similar machines mechanically coupled together; and that this combination may be driven by a steam engine, thus forming a "steam-driven balancer," or may be self-driving. Both methods are common in practice. When steam driven, both machines may be acting as generators; but if self-driving, one, at least, of the machines is acting as a motor, and the other machine may then be acting as a generator or may be running light according to the actual want of "balance" on the system. If the system is in balance, then both machines would be motoring in the case of a self-driving or, as it is more generally called, an electrically driven balancer. The machines forming the balancer may be, and generally are, simply shunt wound, or they may be compound wound. In the latter case the compound winding is so arranged that it acts cumulatively or in the same sense as the shunt winding of that machine which happens to be generating, and differentially in the case of the machine which is motoring.

Compound-wound balancers are rarely used in practice, since they are very apt to become unstable if run in parallel with any other balancing apparatus (*e.g.*, in parallel with a steam-driven balancer or secondary battery). The advantage claimed for a compound-wound balancer is that it can automatically adjust the voltage upon the two sides of the system, whereas the shunt-wound balancer needs to be adjusted by hand.

The fields of a shunt-wound balancer may be "cross connected" or "direct connected." If we identify the two machines as positive and negative, then in any case the armature of the positive machine would be connected between the positive and neutral wires of the system, and the armature of the negative machine between the neutral and negative wires of the system. If cross connected, the field of the positive machine would be connected between the neutral and negative wires of the system and the field of the negative machine between the positive and neutral wires. If direct connected, the fields would be connected similarly to the armature.

Theoretically a balancer may be connected to the system either at the generating station or close to the "feeding-point." When the loads upon the two sides of a 3-wire system are unequal there is a very strong tendency for the voltage across the less heavily loaded side to exceed that across the more heavily loaded side. This want of balance of course occurs at the points of consumption; and since the object of the balancer is to correct the irregularities in voltage produced, it is obviously desirable to let the remedy "touch the spot" if possible. The feeding point is as near "the spot" as it is practicable to get, but even so the balancer is, as a matter of fact, always installed in the generating station so that it can be under supervision. However, bearing in mind the tendency of a shunt-wound motor to increase its speed as its field is weakened, a brief consideration will make it clear that a shunt-wound balancer installed at the feeding point with cross-connected fields would be to a certain extent self-regulating, whereas with the fields direct connected it would not be self-regulating at all wherever it was installed.

It is to be remembered that means are provided to enable the staff of the generating station to ascertain the voltage across the outers at the feeding points, and this voltage may be kept constant. If, as is often the case, the voltage across each side of the system at the feeding points is indicated at the generating station, it may be possible not only to keep the voltage across the outers constant, but also to keep the voltage across each side of the system constant, provided the range of the balancing apparatus is sufficient to deal with the maximum want of balance that occurs.

As regards the experimental circuit already referred to, the main generator consisted of a motor-driven 200/250-volt 25-ampère shunt-wound machine with field-regulating resistance. The balancer consisted of two shunt-wound machines mechanically coupled each with a similar field-regulating resistance. These two machines were similar, each being a 115-volt $\frac{2}{3}$rds B.H.P. motor; resistance of shunt coil (cold) 14 ohms; resistance of field-regulating resistance "all in" (cold) 14 ohms. Assuming an efficiency of 70% for each motor, the full load current would be 7·1 ampères, which gives an idea as to the limiting want of balance that the combination could deal with. This balancer could be connected either at the "feeding point" or at the "switchboard" in the "generating station," and the fields could be either cross connected or direct connected. The load on each side consisted of incandescent lamps, the number of which could be varied.

The "feeder" was 3-wire, all conductors of equal size, resistance of each conductor about 0·5 ohms. In order to economize space the feeder actually consisted of three nominally similar coils of iron wire, and of course the resistance of each "wire" of the feeder varied appreciably owing to the heating caused by the current passing through

it. The voltage at switchboard (S.B.) and at feeding point (F.P.) were read on standard instruments, the remainder of the instruments were only approximately correct. The voltage across the outers at the F.P. was kept constant at 200 volts.

The figure shows diagrammatically the arrangement of the circuit when the balancer was connected at S.B. with fields direct. The modifications necessary in the diagram to represent the other methods of connection can be readily conceived.

Referring now to the table of results;—column 1 shows the position and manner of connection of the balancer; column 3 should equal the sum of columns 8 and 13; column 4 is the sum of columns 9 and 14; columns 6 and 11 show what the load in ampères on each side should have been corresponding to the number of lamps switched on, if the voltage had been correct; column 12 equals approximately the sum of columns 7 and 15; column 15 should equal the sum of columns 16 and 17 very nearly. The currents in the fields of the balancer were not separately recorded; hence it is not possible to connect the ampères in column 2 with those in the other columns.

Set 1 refers to balanced loads, and calls for no special comment except that, after the balancer had been got running correctly for Set 1, the results of Set 2 were obtained by making the loads uneven, correcting the voltage across the outers at F.P. by varying the excitation of main generator, but balancer fields were not altered at all. Hence Set 2 shows the extent to which the balancer was automatic. In this set and in the case of Set 4 the limiting difference of voltage between the two sides of the system was arbitrarily fixed at 20 volts, the number of lamps across the negative side was kept at 14, and the number across the positive side decreased until the limiting difference of voltage was reached (as near as possible). Set 3 shows the limiting want of balance which the balancer could correct for—a limiting current of 13 ampères in the middle wire was decided upon. A further limit was that one of the two machines should have no added resistance in its field circuit; this is a limit which would occur in practice just as much as the limiting current in the middle wire. Set 4 followed Set 3 in exactly the same way as Set 2 followed Set 1. With balancer connections X.F.P. no further readings could be taken in this set, since the balancer could actually correct the voltage with the limiting current flowing in the middle wire (*vide* first series of readings in Set 3).

Although the plant experimented with was small, the result in the table may be taken as correctly typical of what can be expected from a balancer; and so far as is known no similar results have heretofore been published.

The value of the balancer when connected to the system at the feeding point is clearly shown to be considerably greater than when

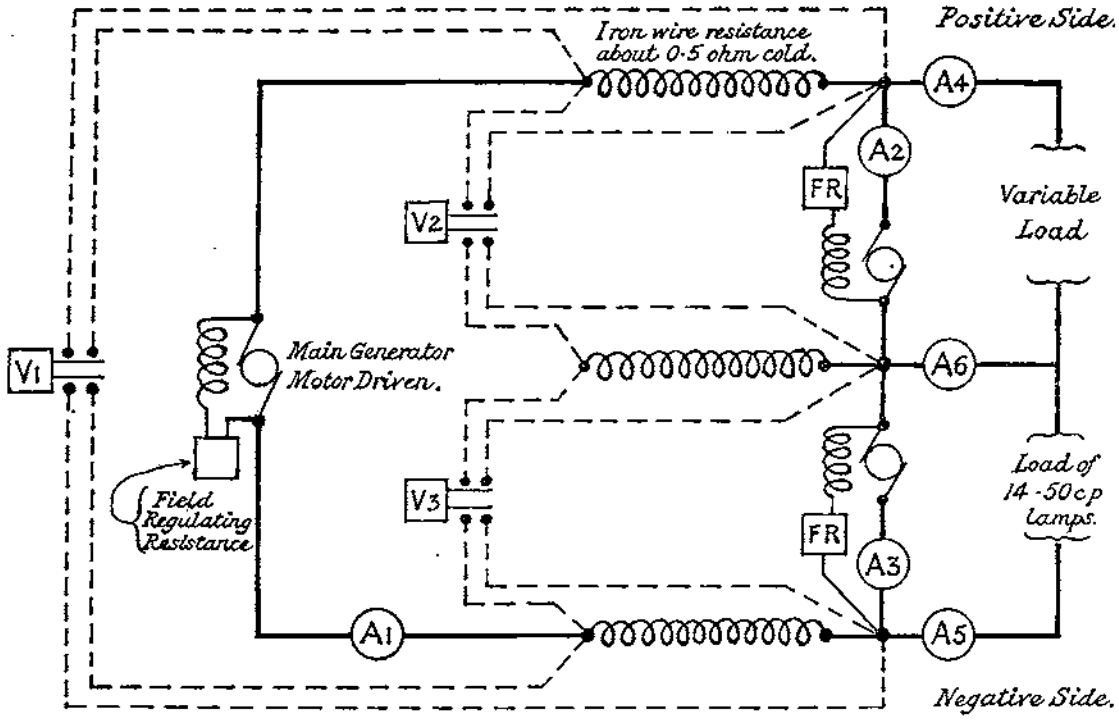
connected at the switchboard ; evidently, the higher the resistance of the feeder the more this difference would become marked. The advantage of the cross-connected fields is also clearly shown. Indeed it is thought that the table of results forms practically a chapter upon electrical engineering for those who can read the language.

It is a most interesting and instructive exercise to draw a fall of potential diagram for each series of the "out of balance" readings recorded in the table. It may be safely predicted that anyone who correctly does this will know more about the action of a balancer on a 3-wire D.C. system than he ever did before !

Connections.	Main Generator.			Positive Side.					Negative Side.					Balancer.		
	Amps.	Volts.		Lamps.		Amps. load actual.	Volts.		Lamps.		Amps. load actual.	Volts.		Ampères.		
		At S.B.	At F.P.	No.	Amps. at 100 v.		At S.B.	At F.P.	No.	Amps. at 100 v.		At S.B.	At F.P.	Mid. wire.	+ve arm.	−ve arm.
1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.	15.	16.	17.
Set 1. Balance. Voltage Correct.																
N.B.	22·5	226	200	14	22·5	22·5	113·5	100	14	22·5	22·5	113·5	100	No Balancer.		
X.F.P.	24·5	229	203	14	22·5	22·5	114	100	14	22·5	22·5	115	100	0	1·2	−1·2
X.S.B.	24·5	224	200	14	22·5	22·5	112	100	14	22·5	22·5	112	100	0	1·5	−1·5
11.F.P.	24·5	226	200	14	22·5	22·5	112·5	100	14	22·5	22·5	113	100	0	1·2	−1·2
11.S.B.	24·5	227	200	14	22·5	22·5	113·5	100	14	22·5	22·5	113·5	100	0	1·3	−1·3
Set 2. Out of Balance. Balancer Fields not Altered. Voltage Wrong.																
N.B.	21	224	200	12	19·25	21	119·5	108	14	22·5	21	105	92	No Balancer.		
X.F.P.	18	219	200	6	9·75	11	118·5	109	14	22·5	20·5	101	91	9·7	6·1	3·6
X.S.B.	19·5	219	200	8	13·0	14·5	115	110	14	22·5	20·25	104·5	90	6·0	4·2	1·7
11.F.P.	19·5	220	200	8	13·0	14·5	120	110	14	22·5	20·5	100	90	6·0	3·9	1·7
11.S.B.	20·25	222	200	10	16·25	17·5	116	108	14	22·5	20·75	106	92	3·3	2·8	0·4
Set 3. Out of Balance. Voltage Corrected by Adjustment of Balancer Fields.																
X.F.P.	19·5	221	200	6	9·75	10	110·5	100	14	22·5	22·5	111	100	12·6	8·4	4·0
X.S.B.	21·0	221	200	9	14·75	14·75	104·0	100·5	14	22·5	22·5	117	99·5	7·75	5·5	2·0
11.F.P.	21·0	224	203	9	14·75	14·75	111·5	100	14	22·5	22·5	112	100	8·2	5·9	2·4
11.S.B.	22·0	222	200	10	16·25	16·25	106	100	14	22·5	22·5	116·5	100	6·6	5·2	1·6
Set 4. Out of Balance beyond Control of Balancer. Balancer Fields as in Set 3.																
X.S.B.	17·5	215	200	4	6·5	7·5	105	108·5	14	22·5	20·5	110	91·5	13·0	8·9	4·1
11.F.P.	17·0	217	200	4	6·5	7·5	118	109·5	14	22·5	20·5	99·5	90·5	13·0	8·5	4·7
11.S.B.	18·5	217	200	6	9·75	11	109·5	109	14	22·5	20·5	108	91	9·8	6·9	3·0

Reference to abbreviations in Column 1 :—

N.B. signifies that the "balancer" was not connected to the circuit at all.
X. signifies that the fields of the balancer were cross connected.
11. signifies that the fields of the balancer were direct connected.
S.B. signifies that the balancer was connected to the system at the switchboard.
F.P. signifies that the balancer was connected to the system at the feeding point.



Reading on A1 entered in col. 2.
" " A2 " " " 16.
" " A3 " " " 17.
" " A4 " " " 7.
" " A5 " " " 12.
" " A6 " " " 15.

Readings on V1 entered in cols. 3 & 4.
" " V2 " " " 8 & 9.
" " V3 " " " 13 & 14.

THE SIEGE OF SEBASTOPOL:

SOME CONVERSATIONS WITH GENERAL TODLEBEN AND SIR JOHN BURGOYNE.

By MAJOR-GEN. HON. G. WROTTESLEY, LATE R.E.

THE correspondence of the Duke of Cambridge, recently published in Col. Willoughby Verner's Military Life of His Royal Highness, contains a letter from Lord Wolseley, written in 1894, on the subject of the Siege of Sebastopol, which revives a long-forgotten controversy. It appears that Lord Wolseley having announced his intention of revisiting Sebastopol, the Duke asked him to examine the ground on both sides of the Harbour and give his opinion on the question which had been mooted about that time—whether, after all, the flank march had not been a mistake, and whether the Allies would not have done better by attacking the Forts on the north side of the Harbour. In reply to this request by the Duke, Lord Wolseley wrote a letter which will be found at p. 384, Volume II., of the book referred to.

In this letter Lord Wolseley expresses an opinion against an attack on the north Forts, on the ground that there was no harbour on that side, but does not enter upon the question as to whether the capture of these Forts would have been of any advantage to the Allies. He writes, however, that in his opinion the English might have taken possession of the south side of the place on the day of the flank march; and he adds "I may be wrong, but I have always in my own mind blamed Sir John Burgoyne for this delay, and for our not having taken Sebastopol on the south of the Harbour the morning after we had crossed the Tchernaya river."

I was not with Sir John Burgoyne in the Crimea, having been invalided from Varna shortly before the expedition set sail. After my arrival in London in November, 1854, I found there was a strong feeling against him in the military clubs, where it was said that he had prevented an assault upon the place in order to have a siege for the Engineers. It was impossible to combat such notions at the time—the outcry against the Generals was too violent; but I was in hopes they would have disappeared after I had published his "Life and Correspondence" in 1873.

It is now well known that Sir John himself was the author of the flank march; and in conversation he has told me that he fully expected the Russians would have been so taken by surprise

that the Allies might have been able to occupy the place as suggested by Lord Wolseley. During the flank march he proposed to Lord Raglan to summon the garrison; this was not done, owing probably to the illness of the French Marshal, St. Arnaud, who was at that time at the point of death and quite unable to attend to any business. Such a summons must have been in writing and signed by both Commanders-in-Chief; no notice would have been taken of a verbal message by any Russian officer in a responsible position. Sir John had had a previous experience of this kind; for when he was sent by Lord Wellington to summon the garrison of the Retiro at Madrid in 1812, the French officer in command of the place was very indignant at a verbal message having been sent to him, and loftily replied "*Les Français ne se rendent pas si facilement.*"

At the time this summons would have reached the garrison, Korniloff had not ferried over the Russian forces from the north side; and Sir John always thought a great opportunity had been lost, as there was every chance that the place might have been surrendered to us at that time owing to the paucity of the garrison.

This seems also to have been the opinion of Todleben. When the great Russian Engineer was in England, some time about 1864, enquiring into our application of iron to coast batteries, I was attached to him officially, and he spoke to me very freely on the subject of the siege. He appeared in fact to have taken a liking to me and on leaving offered to obtain for me a Russian decoration, which I declined with thanks as I should not have been allowed to wear it. The result, however, was that I have been on the most confidential terms with the two chief actors in the siege, and heard a very complete story of it from two opposite quarters.

Todleben was in charge of the defences of the Karabelnaia suburb, opposite to the English; and his opinion was that we might have occupied it when we first arrived before it, owing to the incomplete state of the defences; on the extreme left of the position in fact there were no works at all. This agrees with the account of the position given by Sir G. Cathcart, who sent Lieut. Ravenhill, R.E., to Sir John Burgoyne with a letter stating that, if he was supplied with some additional guns, he could occupy it with the Fourth Division alone. This was on the afternoon of the flank march. Lieut. Ravenhill however did not reach Sir John Burgoyne till between 8 p.m. and 9 p.m. on that evening, as the Headquarters had moved on to Balaklava. According to Lieut. Ravenhill's account of his mission, Sir John's answer to him was, "At any rate the French must be consulted first"; and he left the letter with him and returned to Sir George Cathcart. What became of that letter I never could discover; it was not amongst Sir John's papers when he returned to England, and I've no doubt he sent it on to Colonel Steele, the Military Secretary, or to Sir R. Airey, the Quartermaster-General.

Before the following morning the Russians had moved a very large force across the Harbour, and the place appeared to swarm with troops when Sir John saw it on that day for the first time. In front of the English, the Malakoff Tower was intact and mounted several guns. On the French side, the Dockyard was surrounded by a crenellated wall. In front of all these masonry defences there were earthworks mounting heavy guns. The masonry defences were, however, the main obstacle to an assault, whilst, on the other hand, they could be easily destroyed by a cannonade from a distance, and we had a fine battering train just outside the Harbour of Balaklava. No General would have been justified in hazarding an assault under these circumstances; but as a matter of fact Sir John was never asked his opinion on the subject; it was tacitly assumed by everybody at Headquarters, both French and English, that it would be necessary to cannonade the place before an assault was delivered.

After the publication of Kingslake's history of the campaign, in which he states that Lord Raglan had proposed to take the place by a *coup de main*, but had been prevented by the refusal of the French General, added to objections raised by Sir John Burgoyne, I began to think that perhaps Sir John's memory had been at fault, and I pressed him strongly on the subject. He was very positive that no suggestion of the sort had ever come before him, but to make the matter sure I suggested that he should write to General Canrobert on the subject. Canrobert's reply will be found in the "Life and Correspondence of Sir John Burgoyne"; he states explicitly that Lord Raglan had not proposed to assault the place immediately after the arrival of the Allies before it.

On another occasion Todleben said to me "Abroad they give me all the credit for the defence of Sebastopol, but the person who really saved the place was Admiral Korniloff, who ferried over the whole Russian army in so short a time: he was a splendid fellow, was Korniloff, but he was killed early in the siege." It would appear by this that Todleben considered the place safe as soon as the Russian forces had been brought over to the south side. If this was the case, there is not so much divergence between his views and those of Sir John Burgoyne as would appear at first sight; for the latter, in his first memorandum to the Engineers, printed in the official account of the war, says—"A site must be found for some heavy guns to bear upon the Tower, which seems to be the only obstacle to an assault at any time." This shows that he considered the earthworks at this period to be of small account, as stated both by Todleben and Sir George Cathcart.

There never was any idea amongst the English Engineers of undertaking a regular siege of the place. I can speak positively on this point, for up to a period very shortly antecedent to the embarkation of the troops I was aide-de-camp to Brigadier-General Tylden,

the Commanding Engineer. Our idea was the old Peninsular one of erecting batteries at a distance, in order to subdue the fire of the place, and then assaulting. This programme was fully carried out, so far as the English Engineers were concerned, for I was told by Todleben that at the date of the first bombardment, in October, he was in charge of the Russian defences opposed to us, that every gun on their works had either been dismounted or silenced, and that we should have probably taken the place if an assault had been made upon it at that time. He said to me, he thought his last hour had come, and he put on all his orders so that his body might be recognised if he fell, and never, at any period of his life, had he felt so relieved as when he saw our troops withdrawn from the trenches on the evening of the 17th of October.

The late Major-General Ewart, who was adjutant of the Engineers and was standing close to Sir John Burgoyne at the time, told me he could see that the latter was bitterly disappointed when the orders arrived for the withdrawal of the troops. This took place, as is well known, in consequence of the failure of the French fire, their brass siege guns having been no match for the heavy ship's guns which had been mounted by the Russians, and which added to the blowing-up of one of their magazines had left the advantage of the first day's fire entirely on the side of the Russians.

It may be assumed, I think, that, if at this juncture the Allied Army had been an homogeneous force, the Karabelnaia-suburb would have fallen; and as we know from the sequel, this would have involved the fall of all the defences on the south side of the Harbour. The failure of the operations as first designed arose therefore from the divided command; the whole war in fact, from beginning to end, is an object lesson against undertaking any important military operation with two Commanders-in-Chief of equal rank. But this moral has unfortunately been lost amidst the turmoil of abuse which has been levelled at our Generals, and by the inveterate habit of mankind to seek for a scapegoat for every disaster. There appears, however, to have been in the generals of both armies a lack of that military genius which fires the imagination of soldiers and often leads to great results. If, for instance, the various assaults had been made by combined columns of both armies, the emulation between the two forces would have probably rendered them resistless; and I have been informed by Sir John Burgoyne that this was the last recommendation which he made to Lord Raglan when he left the Crimea in the spring of 1855.

WITH A 'ROUND-UP' IN ALBERTA.

By Capt. E. N. Mozley, R.E.

Any soldier, who wishes to recall his campaigning life, may be recommended to try a few weeks with the cowboys of Western America. If he is a foxhunter, he will be able, even in the heat of midsummer, to realize many of the pleasures of the 'Sport of Kings.' To an observant sportsman the expedition will afford endless opportunities of enlarging his knowledge of the horse and its rider. The soldier will find himself more or less under active service conditions; and, although he will not attain that modern Holy Grail, a couple of medals, yet he will have fewer chances of disaster. It ought however to be added that if he tries conclusions with the bronco,* he may find that being used as a projectile is almost as unpleasant as being hit by one.

The melancholy interest attaching itself to all dying institutions belongs to the cowboy, or cow-puncher as he prefers to call himself. The advance of that herald of civilization, the barbed wire fence, is making horse and cattle ranching impossible. "You should have been here ten or eleven years ago," they will tell you, "when we could ride 50 miles in a straight line without being stopped; another ten years will see the thing out." Indeed, within 20 miles of a railway, the land is worse wired than the most notorious hunting country in England; you can, however, still get along in parts, where it has not yet paid the settler to buy up his quarter section and enclose it.

Turning to the map of Canada, such open stretches may even now be found through the eastern foothills of the Rockies (between the Red Deer River and the frontier) and in the tract south of the main line of the Canadian Pacific Railway and east of the Calgary-Macleod branch line; there is also good ranching country south of Macleod and Lethbridge. Much of the United States is already, I am told, played out for cattle, partly owing to the burnt condition of the grass in summer. To a traveller coming into Canada from Idaho and Montana the favourable change in the character of the grass and the sudden appearance of large herds is very striking.

It was in the foothills of the Rockies, about 20 to 40 miles west of the Calgary-Macleod Railway, that the writer took a trip last summer. A ranch owner kindly allowed him to join his 'outfit,'

* The unbroken or badly broken Western horse.

which was rounding up his 8,000 head of cattle in order to brand the calves and ship "beef," as the steers are generally called.

The 'round-up' is by no means a short annual event, as many people imagine. It is continuous from May to December, the whole 'range' being often covered twice in that time. Were it not for this necessity of finding your stock and bringing it to the cattle-trucks, ranching would indeed be a profitable business. Nature sees to it that your property gets a large increase every year, and makes no charge for keep. The 'range' (that is to say the unsettled tract), with the exception of certain districts which individual ranchmen lease from the Government, is free to all men's cattle. But as these may be anywhere in perhaps twenty or thirty thousand square miles, the business of laying hands on them every year is considerable; and, as all the calves have to be branded, all the cattle must be found.

The 'outfit' is uncommonly like a very small Boer commando. The one the writer accompanied consisted of 15 riders, 1 cook, 2 wagons, and 150 horses; this was rather above the average size. Every rider has his string of 8 or 10 horses, which he alone uses. The men are indeed well horsed: but then it must be remembered that they do the work of a squadron of cavalry.

The hours of work are 5 a.m. to 7 p.m., seven days a week, and one relief as night-herd practically every night; and all this is genuine hard work, covering any quantity of ground, and mounted for the most part on half-broken misanthropes. You will rarely meet a man who works as hard and says as little about it as the cowboys.

Their pay is about 40 dollars a month, besides their keep. It seems poor wages in a land where the unskilled labourer gets a dollar and a-half a day. But, although they could earn more money for less work in a dozen other ways, they come back to the range year after year. Nor have you far to look for the secret: partly no doubt it is the roving freedom, on horseback a dozen hours a day; yet the real reason of the love for this life lies, I think, in the absolute independence with which each man works. They have a foreman, it is true; but if he ever gave an order, it was in some hidden code in which neither writing nor speech had any part. The hour to start, the route taken, the rendezvous, and the subdivision of the work were apparently understood by instinct; and during the many incidents of the day there seemed to be an unanimous consent that there was but one natural way of meeting any situation.

If these men were enlisted for war they should be the finest force the world has ever seen. Their work is very like a soldier's. Most of them have learned to take cover while hunting in the mountains; to all of them the knowledge of ground and its use are the rudiments of their profession. A cowboy, without watch or compass, will tell you both the time and the north by the sun with extraordinary accuracy. His powers of observation with eye and ear approach, as

nearly as is allowed to the white man, those of the Red Indian. He can use a gun: and—rarest of all accomplishments—he can take care of himself. Show him a steer: he will rope, butcher, and cook it as though each art had been his hobby for years. He is veterinary surgeon and farrier (on the rare occasion when the latter is required) to his horses. Moreover is his own doctor; and perhaps it is for this reason that he never goes sick unless he is hurt; if he did, he would be left behind.

This supreme efficiency and spirit is kept up without orders, instruction, or discipline. The cowboy stands out as the ideal fighting man of to-day, who brings his own mother-wit to bear on ultimate situations beyond the law. The British Army could learn much by studying his methods. Ireland, Scotland, Wales, and much of the north and west of England have the requisite training ground, equal in its way to anything in Western America. And we have the men. The glory has not yet departed from Israel. We can still raise in the soldier the spirit of the cowboy (with perhaps slight improvements here and there in the latter's morals). But it will never be done *until the soldier's work is reproductive, until it is something more than mere practising. This* is the great problem, and it is rarely mentioned by our Army Reformers. It is in this that the Royal Engineers have an advantage over the rest of the army; their work has a special use and therefore a dignity. Devise an employment for the Line which, while being allied to soldiering, will be reproductive, and you will again have placed the Army in the front rank of the professions.

But '*à nos moutons*,' or rather cows. Early one morning I was driven to the camp and found only the cook at home; he was armed with a bottle of whiskey (the last remaining from a purchase made when in touch with civilization) and insisted on my being suitably inaugurated as an honorary member of the mess. He always reminded me strongly of John Silver, though he had his proper complement of legs; a man of great discretion and terrific command of lurid metaphor. The camp consisted of two large tents; the cook's tent, perhaps 12 feet each way, ingeniously fixed to the rear of his wagon, which formed its fourth side and contained a folding table and shelves opening into the tent; and a sleeping tent, rather larger than the other, pitched a few yards off. The cooking apparatus consisted of a good stove with a chimney leading through a hole in the roof of the tent.

There is very little to be said about the sanitary arrangements as, like snakes in Ireland, they do not exist. Two days in one spot would certainly breed the plague; but the cow-puncher usually shifts camp twice a day, and does not think it worth while to stow his empty tins under stones in order to preserve the scenery.

The hours for meals were rather old-fashioned — breakfast at

5.0 a.m., dinner at 11.0 a.m., and supper at 5.0 p.m. There was little variety in the bill of fare, which on each occasion consisted of fried meat, tinned vegetables, bread, and strong tea without milk; there was generally a fruit pie to be had by looking for it or making love to the cook. The cowboys spend about twelve minutes a day feeding; perhaps they line their insides with the empty tins; mine was not so armoured, and suffered accordingly.

My first experience was to help the day-herd round-up his horses, which had to be corralled previously to striking camp. Western stable management is exceedingly simple: the horses are never watered, fed, or groomed, and rarely shod; and except when it is their turn to be ridden they are practically free agents.

The country is everywhere splendid grass, and, since camp is always pitched near some creek, there is no difficulty about water. In regard to drinking the horses pay more attention to the rules of health than do the men; the former always stray up stream to get unfouled water; the latter go to the nearest place, where the water, by the time they come for it, is the colour of sepia.

Three times a day—after breakfast, after dinner, and when the night-herds go out—the horses are driven into a corral built of sticks and leather thongs, so that the riders can select and rope their mounts. The western horse will not allow himself to be caught without being lassoed. So, while they are closely packed in the corral, each man goes in, ropes his selection, and fetches it out. There is a great fuss among the horses all the time, each struggling for the outside berth, as the man with the rope is in the middle. They rarely kick each other, and as they are unshod 'treads' are harmless; but they go in for a good deal of mild biting. Sometimes it takes three or four men on the rope or while saddling if the horse is a 'bronco'; such an one, too, will be encouraged to play havoc for a time after being girthed up, so that he may only have his second-best efforts reserved for his rider.* After the selections have been made the 'bunch' are let loose again; if they are to march they are driven to the next camp, otherwise they return to their grazing grounds and keep the herdsman pretty busy: now and then one will stray, but his brand will always bring him back in time.

The cowboys' horsemastership would alarm the authors of the Cavalry Drill Book. Immediately a rider comes into camp he removes his saddle and bridle, and suggests to his horse with a kick that he may now join his friends. (The kick, by the way, is a

* There was one, a 14·2 pony, who was a confirmed bolter. His rider gave him his whole fifty feet of rope; off went the pony, down sat the rider with the rope round his back, throwing his weight against it just as the pony reached the end of his tether. The result was always an end-for-end reversal of the pony, who, after trying every direction with the same conclusion, was finally pulled in and mounted.

recognized instrument of correction). The only time I saw horses watered was just after their feed (not, I admit, grain, which is hardly ever given even at a ranch). Although the horses' manes and tails are profuse, I never saw them touched with a brush.* The only remedy for sore backs, cracked heels, and all wounds is the cook's lard, or perhaps wagon grease; and yet I believe sickness of any kind is most rare. But what anomaly cannot you expect in a country where the saddles weigh more than the vehicles?†

At first sight an Englishman is inclined to laugh at the Mexican saddle as the *reductio ad absurdum* of weight and clumsiness; but nothing less massive will take the shock of the roped steer. The horn, which appears so excellent a thing to hold on to and so unpleasant in case of a fall, has more uses than its chief one, which is to provide a holdfast for the rope: it is an undoubted advantage in mounting a 'mean' (wicked) horse, and also in holding up a leg when shoeing or casting. Stop at Regina on your way out and get the genial riding master of the North West Mounted Police to show you how he teaches a remount to stand fire lying down (to use an Irishism); he can almost do it while you wait.

The stock saddle possesses many other points unusual to our eyes. Its two cinches (or girths), placed as in a lady's saddle, are built up of several returns of broad leather connected by a short raw-hide girth under the belly: nothing less would successfully resist the infuriated efforts of a bronco. The huge wooden stirrups, for winter work when the thermometer may show 50° of frost, the innumerable little thongs for carrying the rope, the 'slicker' (a huge yellow waterproof), etc., complete the equipment.

The bridle is either a straight bar snaffle or a curb with a very high port—never both. Only one pair of 'lines,' as the reins are called, are ever used; a cow-puncher has no time or inclination to be playing around with his horse's mouth. The reins are unconnected, so that they may drop to the ground when the rider dismounts: the horses never move when they are down. My own bridle had the reins riveted together close above the mane, so that I held one rein only; but so well trained are all cow-horses that this was ample.‡

In striking contrast with the general serviceability of the rest of the saddlery are the wonderful decorations, often of silver, with which a

* An interesting use for the long tail was seen with draught horses (or work-horses, as they are called). An uncertain horse will have his tail plaited and tied to that of his companion.

† The Mexican saddle weighs 30 to 40 lbs. Some racing buggies do not reach 25 lbs.

‡ Why are not English horses more broken to neck pressure? We might in time attain to the bit-less bridle which is sometimes used in America; one pattern, called the 'Hackamore,' applies the pressure by means of a strap on the nostrils.

cowboy decorates his bridle and reins. He spends money freely this way.

We said above that the equipment of a cowboy is businesslike; the remarks apply equally to his clothes. He rides in an ordinary long-trousered suit, the coat being usually on the wagon. The trousers are, however, close-fitting and covered by a rough pair of overalls. The boots are Wellingtons, with very high heels to prevent the foot slipping through the stirrup; round the boots are buckled a pair of long-shanked Mexican spurs with huge rowels; a turn of the ankle, instead of a kick, suffices to bring them into action. Some of the spurs worn are very ornamental, costing 5 or 6 dollars a pair; a few men possess silver ones. The headgear is a stiff-brimmed 'Stetson' hat; the cowboy does *not* turn up the edge like a South African hero. A heavy pair of gauntlets complete the kit.

It is curious that men who live on horseback, like Boers and cowboys, should prefer long trousers. They are certainly cheaper, easier to fit, and quicker to put on than breeches. Perhaps the British Cavalry—? ? But we forget what their appearance would be on escort duty!

The ordinary working day is something as follows. At 4.0 a.m. the cook rises to light the fire; at 5.0 everyone is up. After a hurried toilet and a breakfast eaten after the manner of the Jewish passover, the horses, which have by this time been corralled by the night-herd, are roped and saddled. The wagons are packed (this takes rather less than ten minutes) and the 'outfit' gets moving. Three quarters of an hour would cover the whole time from 'reveillé' to 'walk march.'

The riders get on ahead, while the wagons, followed by the horses and their herdsman, make for the next camp, perhaps half-a-dozen miles away. Meanwhile the riders have divided up into three or four groups, and proceed to cover a front of perhaps four miles. What scouts these men would make! They know at all times what their neighbour will do and what he will omit; and they will weigh accurately, with the skill of an engineering pocket-book, the disadvantages of a curved route as against those of a steep grade.

The rounding-up of the cattle and the driving them to the rendezvous is preliminary to the lengthy process of separating the owner's cattle from all other brands and of the former bunch into one herd of steers and another of bulls, cows, and calves. Often the boys are picking out the cattle of two or more owners, which adds to the difficulty. The two herds are then driven near camp and guarded, while the men have dinner. It was always a mystery to me how the herdsmen had their meals; I believe they went without.

In the afternoon camp would probably be struck again and the morning performance repeated. Then, after supper, the calves are branded. A good roper brings them up in turn, lassoed by a hind leg

and bitterly bemoaning their fate, while the cow follows her offspring, lowing an ineffectual protest. A minute suffices for each branding, and the calf trots off bravely, thanking heaven he is still alive. When a well-grown one is brought up a favourite cowboy game is to wrestle and throw it, a feat requiring some dexterity.

Once or twice a yearling steer had to be caught for beef, and once an old cow had to have her horn cut. In such cases two horsemen are required, and the beast is roped, neck and leg. A good cow-horse takes the whole proceeding as a matter of course; he will face the roped steer and throw himself back on his haunches without a visible hint from his rider; he is even trained to hold down the steer while his rider dismounts to tie up the latter's legs.

About half-past eight in the evening the horses are again corralled; the night-herds' horses are then chosen, saddled, and tied to a wagon, and the rest sent out again. Night-herd reliefs are about two hours each, and the rider is kept hard at work. Two men are needed for the cattle. The horses are herded by the same man every night; he is supposed to be off duty by day, but is generally treated as assistant cook, wagon-packer, and harnesser; I do not think he ever sleeps.

Such is the ordinary day, broken only every week or so, when the 'outfit' touches the railway to ship beef, most of which goes alive to Liverpool. On such an occasion the little village, which proudly calls itself a town, has something to talk about. The cowboy and civilization are like two chemical substances, the compounding of which produces strange and noisy results.

The Western horse is astonishingly hardy when it is remembered that he is grass fed. It is probable that his temper arises entirely out of the fierce way he is broken. The cowboy is a very rough rider indeed and a great butcher on a horse; and there is little doubt that it is fear which causes a horse to buck. The men have not time to break carefully and, good riders as they are, do not wish to do so.

A cowboy has his little vanities like the rest of us. One is that he insists on having his spurs and hat on when he is photographed; another that he's jolly well going to have as hard a 'pitching' (buck-jumping) horse in his string as any other man. Great is the joy of the rest when one of them gets into trouble: "Stick him, stick him," they all yell to the unfortunate who, with one line pulled out of his hand and one stirrup lost, is being carried down a hillside on a twisting buck-jumper. Nor must you 'touch leather' (your horn or cantle), or it will be remembered against you.

Well, they can ride; and if they have not got the morals of a guardian angel, they work like men. Keen sportsmen they are too. It is worth going 5,000 miles to see the buck-jumping competition at Calgary fair every July. This year a negro gave even the cowboys a few hints in throwing a steer; galloping alongside it, he would jump on the steer's neck, and throw himself forward until he could grasp

the muzzle with his teeth; then a vigorous twist of the horns and pull with his teeth would bring the steer down on the top of its conquerer, who, however, always succeeded in falling unhurt.

Rousseau's return to Nature has often results which would have been mourned by that philosopher. Yet all these things which we have tried to describe are very good to see and to take part in. And most of all is this realized when one's ways are again ordered and one's paths prescribed by a critical civilization. It is then that the thoughts sometimes turn regretfully to the careless life, the undefeated resourcefulness, and the ubiquitous hospitality of the West.

THE EMPLOYMENT OF SURVEY SECTIONS IN WAR.

By Bt. Col. H. M. Jackson, R.E. (*A.A.G. for Topography, South African Field Force, 1900–02*).

1. War Conditions affecting Employment.

In any discussion of the employment of Survey Sections in time of war it is necessary in the first place to summarise the conditions which would affect essentially the nature of such employment.

For this purpose we may divide all possible—not necessarily probable—campaigns under the following headings :—

(*a*). An invasion of the British Isles.

(*b*). A campaign on the continent of Europe as the ally of some European Power.

(*c*). A war in one of our own Colonies ; *e.g.* in South Africa.

(*d*). A war on or beyond the frontiers of India ; *e.g.* in Afghanistan, or in some other more or less uncivilised country (such as Persia) of which no maps exist or of which the existing maps are incomplete or defective : or in the Colony of some other European Power.

(*e*). Minor expeditions against more or less savage foes in countries only partially surveyed or merely roughly reconnoitred or of which no reliable maps at all exist ; *e.g.* the Soudan, Somaliland, and parts of West Africa.

2. Normal Functions of Survey Sections.

Now the *primary duty* of a Survey Section in war is to carry out a rapid "*Topographic Survey*" of the country operated in on a sufficiently large scale and with sufficient accuracy for military purposes ; and, if necessary, to *reproduce the results* for present use in the field. (A more complete designation therefore of this unit would be "Survey and Mapping Section," or—as in this article—the Section may be considered as divided into Survey and Mapping Detachments).

Other "*secondary*" duties may be summarised as follows:—

(i.). Special reconnaissances.

(ii.). Special surveys of positions chosen for defensive purposes, of important passes, or of other localities which it is thought might be utilised in the course of the operations; and special surveys for fortified camps for Base Depôts, or other similar purposes.

(iii.). (Mapping Detachment). Reproduction of maps obtained in the country, or captured from the enemy, or in order to augment any original supply of maps which may have run short.

(iv.). (Mapping Detachment). Reproduction of results of special reconnaissances and surveys, carried out by the Survey Detachment or by individual officers or otherwise obtained.

(v.). (Mapping Detachment). The preparation of special maps for issue with orders.

3. EMPLOYMENT OF SURVEY SECTIONS UNDER VARIOUS CONDITIONS.

With the above data for the duties of Survey Sections we may now consider their employment under the various conditions indicated in 1.

In British Isles.

(*a*). In the British Isles the Ordnance Survey maps are so complete and up to date that it is probable that, in the event of an enemy's force having effected a landing, the chief duties of Survey Sections with our forces would be of a "secondary" nature, viz., those detailed as (i.), (ii.), (iv.) and (v.), especially the last mentioned, in para. 2 above.

On Continent of Europe.

(*b*). In any campaign on the continent of Europe (in conjunction probably with another European Power) our troops would presumably be supplied by our Intelligence Division with maps of the theatre of war. Under these circumstances also the duties of Survey Sections would therefore probably be limited to the "secondary" duties detailed in para. 2, subsections (i.) to (v.). It is improbable that a Survey Section would be able to produce any general maps superior to the published maps of the country, unless the scene of operations were, for instance, in parts of Turkey, in which case the duties of a Survey Section would to a certain extent come under the classification of "primary" (*vide* 3 (*d*) and (*e*), pages 276, 278).

In Colonies and Recent experience in S. Africa.

(*c*). In considering the case of the employment of Survey Sections in a war in any of our Colonies, our experience in South Africa has been so recent that it will perhaps be useful to state shortly what was actually done in this respect in that country during the late war.

At the beginning of the war the maps available for the use of the Army were :—

In Cape Colony.—A general map only (scale about 12 miles to the inch).

In Natal.—An obsolete general map on a small scale and a military reconnaissance survey of the Biggarsberg region, including most of the northern part of the Colony, but unfortunately stopping short at Ladysmith.

In the Orange Free State.—Maps compiled from rough transcripts of the "diagrams" of the Farm Surveys, one series prepared by the Intelligence Division, the other by a private firm in Cape Town, both on the scale of about 4 miles to the inch, both incomplete and unreliable, except perhaps as regards the main through roads, neither in any sense a topographical map.

In the Transvaal.—The southern portion only included in the same two series above mentioned ; also a general map of a superior kind, on the scale of about 7 inches to the mile, compiled and reduced from the original diagrams of the Farm Surveys.

Of all these maps the general maps of the Cape Colony and of the Transvaal were only really of use for General Staff or Administrative purposes. They were, of course, on far too small a scale for tactical purposes, or even for the regulation of the movements of troops with any certainty. This fact in the case of the Transvaal map ("Jeppe's"), which (on account of its convenient size and the excellent way in which it had been got up) was too often used even when more accurate maps on a larger scale had become available, became only too obvious on several occasions. The only good military map—as far as it went—was that of Northern Natal ; and that unfortunately did not go far enough. The other maps above mentioned were to a limited extent useful for the general regulation of the movements of troops, but were not adapted for elaborating any details or for tactical purposes. They were, moreover, in many parts incomplete and inaccurate, even in the distances between well-known places.

Besides "Maps" proper, there were prepared and issued under the direction of the Intelligence Division a number of "Road Reports" and "Route Sketches" of various kinds.

Such then were the cartographic data with which the last South African War was commenced.

The arrangements during the course of the war for improving and adding to these were as follows :—

(1). With the first force sent to Natal was half a "Mapping Section," consisting of 1 officer and 2 or 3 N.C.O.s (R.E.).

(2). In October, 1899, another half "Mapping Section" was sent out to Cape Town, consisting of 1 officer, 1 N.C.O., and 1 sapper (R.E.).

These detachments were intended chiefly for the reproduction of maps, sketches, etc., in the field, but were provided with means for rough surveys and reconnaissances.

(3). Early in 1900 a "Survey Section" (No. 1), consisting of 1 officer and 8 N.C.O.s and men (R.E.), was sent out.

(4). In May, 1900, another "Survey Section" (No. 2) of the same strength and composition was despatched.

(5). Almost at the end of the war 2 more "Survey Sections" (Nos. 3 and 4) were sent out; but these only arrived in time to complete the surveys of battle-fields for historical purposes.

The strength of the Topographic and Mapping Branch of the Field Intelligence Department for the War period of 1900–02 may therefore be taken as 2 "Survey Sections" and 1 "Mapping Section," consisting in all of 3 officers and from 20 to 30 N.C.O.s and men, including extra R.E. and civilians employed from time to time in compiling, drafting, and printing.

The total area surveyed and mapped (on the scales of $\frac{1}{2}$, 1, and 2 inches to the mile, chiefly on the $\frac{1}{2}$-inch scale) was 13,730 square miles. Of this total, part was published and issued in 12 original maps, the remainder was incorporated in maps compiled from the Farm Surveys of the Colonies. Of these compiled and partly revised maps 116 different sheets were issued—viz., 62 for the Transvaal and part of Natal, 21 for the O.R.C., and 33 for the Cape Colony. Besides these, 3 general maps on smaller scales of parts of Northern Natal and Zululand and of the Transvaal and O.R.C. were compiled, printed, and issued.

In all 463,600 maps of all kinds were printed by the "Mapping Section," of which 307,980 were issued.

"Miscellaneous" work included:—Reconnaissances of the enemy's positions at Paardeberg and Poplar Grove; special surveys of and round Bloemfontein and Pretoria; and the compilation and printing of several thousands of reconnaissance sketches, reports, etc., etc.

It will be seen from the above statement that the Survey and Mapping Sections employed during the late war in South Africa did actually carry out to a certain extent—perhaps as far as circumstances admitted—all the various kinds of duties detailed in 2 as appertaining to such detachments. But it is evident that their strength and organisation were quite inadequate to carrying out these duties to their full extent; for the area of the military operations from first to last may be put roughly at about 300,000 square miles. Indeed, had it not been for the material found available at the several Colonial survey offices, it is improbable that the original map supply could have been improved except for comparatively small areas here

and there over the immense tracts of country traversed by our columns.

Unfortunately the material derived from the Farm Surveys was of very unequal value. In the older Farm Surveys, more especially of the Cape Colony and Orange Free State, it was practically valueless from a topographical point of view. But most of the Transvaal Farm Surveys, being more recent and better in every respect, afforded very fair material; so that some of the maps of this part of the theatre of war, when revised by means of actual survey, and by sketches and information supplied by staff and regimental officers in the field, became quite useful for military purposes. However, maps so prepared, not based on any systematic topographical survey, must always include much information of unequal or doubtful value, even if not positively misleading. The best that can be said of them is that they were issued *faute de mieux*, and that the utmost was done with the means at disposal to improve them.

It must be remembered, however, that the systematic preparation and issue of these maps did not begin until *after* the main Boer Army had been defeated and dispersed near Belfast, though for that action and for the action known as the Battle of Diamond Hill maps in the form of "sun-prints" had been issued. Of these, the latter, owing to hurried preparation, was by no means so good as it might have been. From November, 1900, the preparation and issue of maps was systematised and proceeded regularly.

It is to be hoped, however, that in the event of another war—of whatever kind—in South Africa, it may not *then* be necessary to make use of the experiences here related, but that *before then a proper topographic survey of these Colonies will have been carried out.*

In fact, the best employment of Survey Sections in our Colonies *is in time of peace*—in the carrying out of deliberate surveys, which may be useful not only for future military purposes but also for the immediate purposes of civil administration and for the development of the Colonies in all directions in which such surveys are necessary. The employment *then* of these units in the same countries *in time of war* would be limited to the special or "secondary" services detailed in subsections (i.) to (v.) of 2.

On Frontiers of India.

(*d*). The subject of the employment of Survey Sections on the frontiers of India is fully dealt with in the *Handbook of Professional Instructions for the Topographical Branch of the Survey of India* (Chapter on "Frontier Reconnaissance"). Moreover, any further information or discussion on this subject should certainly be supplied by one of our officers who has been chiefly employed on such work on the North West Frontier. My own experience on the Eastern Frontier, though with troops, has been more in geographical than in topographical work, and was mostly individual or in company with

only one assistant. Any original data I could supply would relate chiefly to minor details of equipment, etc., which will appear in their proper place.

The work of the Survey Sections or "Parties," supplied by the Survey of India for employment with columns operating against the hill tribes of the Northern and North-Western Frontiers, has been of a very important nature, and has proved extremely useful in subsequent military expeditions and in the general administration of the Frontier. The duty of these detachments has been generally to map as much as possible of the country traversed by the columns. From the skill, energy, and adventurous spirit of the experienced topographers employed on these expeditions, the favourable nature of the country and the fact that importance is wisely accredited to such work in India, has resulted the mapping of the greater part of the frontier regions which, until quite recently, could not be entered in a peaceful way for survey purposes. In a hilly country free from forest or bush, skilled topographers, if provided with proper escort, or if accompanying the flanking columns of the general advance, can even map a certain amount of country in front of the main column under favourable circumstances and in clear weather. The instant utility of such work is inestimable. A compilation of the survey reports of these Trans-Frontier Expeditions would be of great interest, and would supply invaluable material for a discussion on the subject of this article.

In the event of a regular campaign, entailing the employment of considerable bodies of troops *beyond* the Indian Frontiers in countries as yet unsurveyed though perhaps partly reconnoitred from time to time by individuals, a more complete field service Survey organisation would be necessary than has been required for ordinary Trans-Frontier Expeditions. However, India has always the advantage of possessing a number of trained officers and men who could, if required, be employed on such work. The excellent work done by a "Survey Party" in China during the recent Pekin Expedition affords a case in point. If the trained personnel is immediately available, it is only a question of proper equipment and judicious employment, with due protection when necessary. Given such a personnel, the control of several sections would offer no difficulties.

The employment of Survey Sections in a campaign in such countries as Persia or China, in company with a large force, would probably be subject to the same conditions as in the case last discussed. But it is probable that in a Persian campaign, for instance, we should have to depend partly on personnel supplied from England; and this, if present conditions still prevail, not being so well trained or so experienced as the personnel available in India, would demand a more elaborate organisation and a closer control.

From my own experience in the recent war in South Africa I am certain

that, for the army in the field to derive all possible advantage from these technical detachments, it is necessary that there should be in general charge of them a technically qualified and experienced officer on the Staff of the General Officer Commanding, *i.e.*, a "Staff Officer for Topography."*

But the chief lesson to be learnt from the South African War is that, in the course of an advance through an unmapped or inadequately mapped country, whether actively hostile or not, all available trained men should as soon as possible be put on to the "Survey" or "Reconnaissance" of as much of the country traversed by the columns as they can see. Even if little work can be carried out *in front* of the advance, one can never be certain that a knowledge of the country on either side or already passed over will not be just as important for military purposes a few days afterwards.

If the country is actively hostile as a whole, *i.e.*, if apparent non-combatants would attack isolated individuals or small detachments, the number of surveyors employed must be conditioned by the number of troops available for escorts. In the late South African War regular escorts were never available for survey or reconnaissance purposes; officers in charge of Survey Sections had therefore to make their own arrangements. The conditions in this war were, however, in this respect quite exceptional, owing to the extraordinary mobility of the enemy and the boldly independent action over immense tracts of country of numerous small "commandos," especially in the latter phase of the war, from the end of 1900 to the termination of hostilities. So that, even if an attempt had been made during that time to carry out extensive surveys by means of numerous protected sections, the probability is that such small isolated detachments would have fallen victims to the enterprising enemy. This indeed was actually the fate of one unprotected and unsuspecting survey section during the late war.

In the first phase of the war, however, if a number of trained and experienced Survey Sections had been available for work in the Cape Colony and in parts of the Orange Free State, when the Boer forces were rolled back by our advance and by the relief of the beleaguered garrisons, and if it had been possible then to predict the future course of the war, it is probable that much work could have been done which would have proved of inestimable value during the operations of 1901–02. But it is easy to be wise after the event. *It remains to us to profit by the experience.*

In Savage Warfare.

(*e*). The employment of Survey Sections with minor armed "expeditions" into hostile countries is best typified by our experiences on the Indian Frontiers, which have been referred to in the preceding paragraphs. There remains therefore little to add under this heading.

* See under 4 below.

Moreover, what may reasonably be expected of surveyors on such expeditions must always depend largely on the nature of the country, on the climate, on the disposition of the inhabitants generally, and on the strength and character of the combatant portion of them. On small expeditions—consisting of only one or, perhaps, two small columns—in forest or bush-clad country, or in country in which the operations are limited by conditions of water supply or by other local considerations to a single line of advance, it would only be possible to employ two or three men; and these could perhaps do no more than survey and map a very short distance to either side of the route.

It must be remembered, however, that such small expeditions, generally undertaken for a punitive object with no immediate intention of occupation, are necessarily only temporary in their effect and have often to be repeated. Thus the geographical or topographical information acquired on any one such expedition—however meagre it may appear, and though it may have been of no use at all on that particular expedition—may prove of great use on a subsequent one into the same country. In the selection of individuals or detachments for such work, the chief essentials are experience, quickness, energy, and activity. An equipment exactly adapted to the country and to the conditions under which the work must be carried on is also a very necessary consideration.

4. ORGANISATION.

Having discussed the various circumstances under which Survey Sections may be employed in war, it remains to consider the organisation (and subsequently the best equipment) necessary to render such employment effective.

With due regard to the purposes for which Survey Sections may be employed, the normal effective "unit," *i.e.* the maximum number of surveyors that can as a rule be effectively controlled by one officer for independent work, appears from experience to be from 6 to 10. But since in the ordinary course of war it is usually impossible to replace without considerable delay a technically trained officer, it seems very desirable to provide for two officers with each Section; and there is moreover the mapping detachment to consider. A normal Survey Section may therefore be defined as 2 officers, 8 surveyors and 3 lithographers, with the necessary drivers and batmen according to circumstances. For *authorised* normal Establishment see Appendix.

When there are more than 2 Sections the Staff Officer for Topography* might be provided with an assistant, to be employed in inspecting the work of the Sections, in ascertaining their requirements, in arranging details for their supply and transport, and in issuing the maps. As a rule it would be advisable for the Staff Officer at Headquarters to keep with him the "*mapping* detachments" of the Survey

* See under 3 above.

Sections, and to superintend personally the compilation and reproduction of maps and their issue to the troops. Thus the staff of the Topographic Branch of the Field Intelligence Department should consist of officers who are well versed not only in survey methods and procedure but also in all the technical details of the reproduction of maps.

In the case of minor expeditions as in 1 (*e*), or in such special cases as are indicated in 1 (*a*) and 1 (*b*), the unit section would of course be modified to suit the conditions and requirements of the case. In some cases only one or two special officers or N.C.O.s would be selected for the work.

5. EQUIPMENT, ETC.

The equipment of Survey Sections, or of Survey detachments, or of individuals detailed to expeditions for survey purposes, must depend on the nature of the country operated in and the nature of the operations.

The details of equipment and transport of a normal section having now been prepared and authorised, it is easy to modify them for adaptation to each special case.

The authorised Lists are given in the Appendix, with a few additional suggestions.

6. TRAINING OF SURVEY SECTIONS.

In order that Survey Sections or Detachments may fully justify their employment in time of war, it is obviously essential for the personnel of which they are composed to be thoroughly trained in time of peace in carrying out rapidly and with sufficient accuracy the kind of work which will be required of them on active service. For this purpose their training should be under war conditions. It is evident that there is a great difference between carrying out a survey deliberately and carrying it out within certain limits of time and under conditions which may preclude the whole of the area under survey being actually visited.

In India we may generally count on the Survey of India Department being able to supply a sufficient number of trained topographers used to working under practically service conditions; but even in India this supply will be gradually diminished as the surveys of the Frontiers are completed and the topographical surveys generally become reduced to revision or re-surveys on larger scales.

In the Colonies, however, we have no such supply to draw upon; and in the British Isles we have only a relatively small number of men, available at any one time, trained in the Ordnance Survey and at Chatham. The Survey Sections sent out to the recent South African War were all drawn from the Ordnance Survey, and most of

the men were not trained for the special work required of them until after the commencement of the war.

That these men did so well says much for the administration of the Ordnance Survey and the officers who carried out the training, as well as for the natural ability of the men themselves. This training in the Ordnance Survey Department has now been considerably extended and regularly systematised; so that we may in future hope to have a fair supply of military topographers whenever their services are required.

I would strongly recommend, however, some instruction in riding and horse management—*not in "equitation."* It should be possible to attach the men to mounted infantry units for short periods with this object.

Some arrangement should also be made by which N.C.O.s and men transferred from the Ordnance Survey to Survey Sections on active service should not lose pay, as was often the case during the South African War. However efficient a man may be technically, it is not probable that one will get the best out of him, if he thinks he is being unfairly treated as regards pay, etc. Besides he often leaves a wife and children at home dependent on his pay for the necessaries of life.

There is yet another point to consider with reference to the training of military topographers, viz., whether the ground available is suitable for this purpose, *i.e.*, whether probable war conditions can be fairly attained.

In a country like the British Isles, in which most of the land is enclosed and the wilder parts generally preserved for game, it is difficult to find large areas suitable for training. In the Colonies, however, more particularly in Canada and South Africa, there are immense areas practically unsurveyed topographically, which could be used for the training of an unlimited number of men. One of the many advantages to the Empire of the proposed Topographic Survey of South Africa was that it would have afforded such a training school. Now that, in default of the promised co-operation of the South African Colonies, this particular scheme must apparently be postponed, it can only be hoped that some other means may be found of attaining the desired end independently of the varying conditions imposed by the circumstances of Colonial Governments.

7. NECESSITY FOR ENLARGING THE SCOPE OF THE TOPOGRAPHICAL SECTION OF THE WAR OFFICE.

The want of proper maps during the late South African War, the still incomplete and unsatisfactory state of the maps of the South African Colonies and of those of the greater part of other Colonies, and the fate—as it appears at the present time—of the proposed

Topographic Survey of South Africa, all point to the conclusion that what is required is to extend the scope of the "Topographical Section" of the War Office, so as to assimilate this "Section," as far as the general conditions of our army admit, to the Military Topographical Departments of the Continental Powers.

8. SURVEY METHODS.

It is not proposed in this article to enter into any details of the technical work of Survey Sections. But a short discussion of this subject in general terms may perhaps be useful.

The main principle on which all survey work, however rough or hurried, should be carried on is that it should be based, whenever possible, on some kind of triangulation, even though this may be very far from rigorous. Unless this is done the true value of any detail work can never be even approximately estimated, nor can separate surveys or reconnaissances of any kind be connected with any certainty of accuracy. Moreover, any time spent on triangulation is saved many times over in the increased rapidity and completeness with which detail work can be carried on between points previously determined; and, generally, it may be said that the greater the number of fixed points given to the detail surveyor the more accurate—*ceteris paribus*—will be the resulting map.

The main principles of precise surveying hold good in fact for even a rough reconnaissance; and it is the intelligent adaptation of methods to the required result that is the chief criterion of the value of that result and of the capacity of the topographer. It is in this connection that the actual experience of work under difficulties is so necessary. Without such experience the military topographer, when he is first started under service conditions, will usually find himself hopelessly at sea; and the opportunity for the immediate usefulness of his work may have passed away before he has found out how to adapt himself to circumstances.

REPRESENTATION OF GROUND.

It is in the quick mental grasp, and in the intelligent representation in a rapid way, of the characteristic shape of natural features and of the relative steepness of slopes that considerable experience and training is most necessary; the more so because the education of the eye to see correctly—which, after all, is the main thing—is not facilitated by the general conditions of modern civilisation.

In this connection I have noticed, with regard to both officers and men trained in England, that there is a tendency to regard the "form-lines," with which they have been taught to represent ground, too much as if these were rigorous contours to be carried through the map as such without regard as to whether they serve to convey a correct impression of the ground or not. So much is this the case that—for

instance—I have seen maps made on this principle which I have quite failed to recognise as representations of ground that I knew intimately. The military topographer should be taught to use this means for the representation of ground in a more intelligent and elastic way.

In military surveys there is seldom time for systematic contouring, nor will the purpose of the work usually (*i.e.* except in special cases) justify the expense. The essential is to preserve a sufficient control of the "form-lines" by means of numerous observations of relative heights—by clinometer or aneroid--and to record on the final map a sufficient number of these heights to answer all probable requirements.

In this respect greater attention should be given to the systematic and intelligent use of the aneroid barometer.

TACHYMETRY.

There is one other question in connection with survey methods which I think may be usefully mentioned here, viz., the rapid measurement of distances when the topographer has no fixed points within view.

It is true that in very rough work distances may be timed or paced with good results, provided there are connection or closing points of some kind at intervals; but, for any sort of work that may be called "Survey," such methods are not good enough, except for very minor detail at very short distances between known points. What is required is some means of distance measurement in cases in which direct measurement—*i.e.* by chain, band, rope, or "perambulator"—cannot be carried out and where positions cannot be interpolated from known points.

"Tacheometric," "subtense," or "stadia" methods of measurement have been little used in England or in India compared to the extent to which they are utilised on the continent of Europe and in the United States of America. It appears advisable that military topographers should be trained to some such methods of measurement; and that some light form of telescopic alidade, fitted with stadia wires, and a light telescopic stadia rod should form part of the equipment of each plane-tabler, not necessarily to be always taken by him into the field, but to be at hand for use when necessary. With the same object the theodolites used for the triangulation should also be provided with stadia wires or lines. For mounted work on emergency it will be well also to supply the Sections with one or two good range-finders of the pattern found to give the best results.

REPRODUCTION OF MAPS IN THE FIELD.

It is obviously essential that Survey Sections should be provided with means for the reproduction of their field sheets for immediate use. Hand lithographic (or zincographic) presses have lately been

made and approved, which, in one or other of the three patterns prepared, are adapted for any sort of service or mode of transport. With these the field work would be got on to the stone or plate for reproduction by "tracing-transfer" *under ordinary circumstances*. Circumstances may often arise, however, in which it may be essential to be provided with some more rapid means of reproduction than this; for tracing of anything like close or intricate country may take a long time. It appears therefore advisable that some photographic process apparatus should be provided, even though generally it might have to be utilised at the Base of operations. The "Vandyke Process" is one of the most suitable, and provided a fair water supply were available in the country to be traversed, the apparatus for this process might accompany the Section. In any case the best form of "Sun-printing" apparatus and materials should be supplied for use at the front.

It must be remembered, however, that, in order to make use of photographic methods of any kind, the field sheets must be penned in with this end in view, or tracings on tracing cloth of the field sheets must be kept up suitable for photographic reproduction. The tracings would of course, if kept entirely in opaque black and red, be suitable for any process—including "Sun-printing"; and, if the surveyor gets into the habit of tracing as much as he has quite finished every two or three days, or even every week, this extra work soon ceases to appear unduly irksome. In a hostile country moreover it is often necessary, in order to minimise as much as possible the chance of large quantities of work being entirely lost, to keep tracings in camp of the work which is taken out into the field.

In default of tracings the field sheets themselves should be penned in so that fair photographic negatives may be obtained from them by means of an ordinary Photo-Process Camera. There would be no difficulty in adapting the apparatus required for this method to any sort of transport.

I have also touched on this question of photographic reproduction in my remarks on the authorised Equipment for Survey Sections.

APPENDIX.

DETAILS OF PERSONNEL, TRANSPORT, AND EQUIPMENT OF SURVEY SECTIONS.

Note.—Since this article was written, in S. Africa in June, 1905, I have had access to the lists of authorised establishment and equipment of Survey Sections and have obtained permission to publish them. I therefore insert here these authorised lists in place of those I had prepared independently; but I have also attached to each such suggestions or recommendations as I think may tend to the further efficiency of the units in question. Those who have had any experience in the production of maps on active service, or under difficult conditions in wild and sparsely inhabited countries, will know that no apology is necessary for the discussion of details which, to the ordinary reader, may appear trivial and insignificant.

PERSONNEL.

(*Authorised Establishment*).

2 Officers (1 Captain and 1 Subaltern).
8 Surveyors (N.C.O.s, including 1 Sergeant, and Sappers).
3 Lithographers.
1 Shoeing and Carriage Smith.
2 Drivers (R.E.).
1 „ (A.S.C.—2nd Line Transport).
4 Batmen.

Total 21

TRANSPORT.

5 Riding Horses.
5 Draught „
3 Carts (of which 1—a light, spring cart—to be provided locally).

Remarks on Authorised Establishment

Drivers.—It would probably be found more economical to substitute native for R.E. or A.S.C. drivers in Africa or Asia.

Riding Horses.—I am strongly of opinion that in any but very hilly country all surveyors should be mounted or provided with light carts. The officers should of course be mounted. I found in S. Africa that to obtain any fair out-turn of work it was always necessary to mount my men; and eventually they nearly all learned to work with ponies.

Draught Horses and Carts.—Provision should be made in case of pack transport being necessary. For this purpose pack saddles should be authorised as alternative articles of equipment; and the "Bullock Trunks" specified should be such as may be used as "Mule-Trunks,"—with rings and straps for attachment to saddles. All necessary survey and mapping instruments and stores can be carried on pack animals.

INSTRUMENTS AND STORES.

(Authorised List for a Survey Section).

Instruments	Alidades, telescopic	2
	Bags, canvas	12
	„ letter, leather	2
	Balances, spring, 30 lbs.	1
	Bars, subtense	2
	Bottles, ink, fountain } „ „ surveying }	16
	Bullock Trunks	6
	Cases { Carrying Instruments, padded leather, with Straps ...	3
	Cases { Sketching with Straps, 17″ × 15″	4
	Cases { Tin and iron, for Plans, etc.	10
	Cavalry Sketching Boards	2
	Chains, measuring, 100 feet, with 10 Arrows, Sets	2
	„ „ Arrows extra, Sets of 10	2
	Chairs, Camp	2
	Covers, Instrument, waterproof...	3
	Curves, French, Sets	1
	Erasers, with sheath	12
	Flags, Station	24
	Hones, Oil...	1
	Aneroids, 2½″, graduated according to circumstances ...	10
	„ 5″ „ „ „	2
	Binoculars in sling Cases, Zeiss Pattern	8
	„ „ Extra Power Zeiss	2
	Clinometers, "Tangent," Indian Pattern	8
	„ „ „ „ Cases and Slings for	8
	Compasses, Beam, 3 feet, graduated Inches and Decimals...	1
	„ „ 2 „ „ ...	1
	„ Bowsweep, Pen	10
	„ „ Pencil	10
	„ Prismatic, Hand, luminous	8
	„ „ „ Cases, leather with Slings	8
	Compasses, Prismatic, 4½″, with Tripod	2
	„ „ „ Cases, leather Sling with Straps for	2
	Compasses, Proportional	2
	Heliographs, 5″ Mark III. in leather Case, with Stand, complete	2
	Heliostats	3
	„ Cases and Straps for	3
	Holdalls, Leather, fitted with Compass with shifting Leg, Pen Point, Pencil Point, lengthening Arm, Pen Bowsweep, Pencil Bowsweep, Pens Drawing single (2), 6″ Ivory Protractor, 6″ Ivory Parallel Rulers, Knife and Turnscrew combined...	10
	Levels, Pocket (Abney's)	8
	„ „ Cases, leather Sling with Straps for	8
	Pantagraph	1
	Perambulators	1

Instruments	Protractors	Brass, 12″ Circular	2
		Celluloid, 12″ ditto	3
		Ebonite, 6″ ditto	2
		Ivory, 6″ Rectangular	6
	Rulers, parallel, 18″		1
	„ „ 6″ Ebonite		4
	Scales	Ivory or boxwood, 1″ to 1 mile	12
		„ „ 2″ „	4
		„ „ 6″ „	4
		„ „ 1″ to 10 miles	2
		„ „ 1″ to 2 miles	12
		Gunter's, brass, 2 ft. divided into Inches and Decimals	1
	Instruments, drawing, Box, superior, with Instruments complete		2
	Tables, Plane, R.E., 18″ × 24″, complete with canvas cloth Covers, Tripods, magnetic Trough Compasses in leather sling Cases with Straps, and Sight Rules in leather Cases with Straps		9
	Tables, Plane, 18″ × 18″, Portable (with accessories as above)		4
	„ „ „ spare Screws for		12
	Tapes, measuring, 100 ft.		12
	„ „ steel in "Boxes"		4
	„ Boxes for 100 feet Tapes		6
	„ Steel, 300 feet		1
	Telescopes, "Deer-Stalking" Pattern		1
	Theodolites, transit, 5-inch		2
	„ „ 3″ or 4″		1
	„ „ Telescope for, with extra power, for 5″ Theodolite		1
	Thermometers, swing, in brass Tubes		8
	Watches, Keyless, "½ Chronometer"		3
Knives, Pen, pocket			12
Lamp, Reading, in Box			1
Lanterns, Bicycle...			4
„ Camp			2
Needles, Sailmakers'			12
Palms, „			1
Poles, Traverse, Supports for, and Fittings for plumbing			6
Planispheres, "Phillips," 1 North and 1 South			2
Spirits, methylated ... ... Gallons			2
Stones, Oil, Carpenters', 8″ long in wooden Frame			1
Straight-edges, steel, 3 feet			1
Tools	Axes, hand		2
	„ felling		1
	„ Pick		2
	„ Pick, Helves for		2
	Billhooks, longhandled		1
	„ shorthandled		1
	Awls, Brad, Carpenters'		6
	„ Handles for		6
	Hammers, piling		1
	Roll of, to contain Cold Chisel, Firmer Chisel, 6 Files, 3 Gimlets, Claw Hammer, Pair of Pincers, Handsaw, etc.		1
	Spades...		2
	Tools for repairing Saddlery ... ... Sets		1
Umbrellas, Gig			8
Weights, Leaden, for Papers			8

Stationery, etc. :—

Books	Almanacks, nautical		2
	„ „ for following year		2
	„ Whitaker's		1
	Angle		7
	Observation		12
	Astronomical forms S.M.E. and Notes		7
	Hints to Travellers		1
	Logarithm Tables, Chambers', Shortrede's or Babbage's		2
	Memorandum		12
	Road		30
	Text Book of Military Topography, Parts I. and II. of each		10
Chalks, Coloured.	Blue	Boxes	1
„	Green	„	1
„	Red	„	1
„	Yellow	„	1
Colours	Boxes of, to contain Lake, Yellow Ochre, Gamboge, Burnt Sienna, Prussian Blue, Indian Ink (in Sticks), and Brushes, complete		10
	Burnt Sienna	Cakes	12
	Crimson Lake	„	12
	Gamboge	„	12
	Indian Ink, 3" Sticks		24
	Indian Ink	Bottles	12
	Prussian Blue	Cakes	12
	Yellow Ochre	„	12
Envelopes	No. 1 white		100
	No. 2 medium white		100
	No. 3 small		100
Gall, Ox		Pots	1
Gum Arabic		lbs.	½
India rubber		Pieces	24
Ink	Powders, black		3
	„ red		1
	Black	Pints	2
	Red	„	2
Line, log		Hanks	2
Maps, Celestial		Sets	1
Paper	Bank post	quires	3
	Blotting	„	2
	Drawing, D.E. "handmade," 170 lbs.	„	1½
	Foolscap, blue crossbar	„	10
	„ plain	„	2
	Note, white	„	3
	Tracing, D.E.	„	2
	„ Linen	yards	96
Pencils	H.B.		24
	H.H.		24
	H.H.H.H.		24
	H.H.H.H.H.H.		24
	Hair, Camel		8
	„ Sable, assorted sizes		24

Pens, Steel	Holders		12
	Mapping, No. 659	Cards	6
	Mitchell's J	Boxes	2
	Ordnance	„	2
Pins, Artists'		Doz.	12
Saucers, ink		Sets	8
Skins, chamois			2
Twine	Medium	Balls	3
	Thick	„	4
	Thin	„	2

Remarks on Authorised List of Stores for Survey Sections.

Alidades, telescopic.—Should be provided with stadia lines or wires and small vertical arcs (half circle), and the whole packed in flat cases of stiffened leather with slings. Small levels should also be provided.

Compasses, bowsweep, pen and pencil, 10 of each.—These seem unnecessary as these instruments are supplied in the holdalls and boxes.

Compasses, proportional—6.—I would recommend one of these for each surveyor and 2 for office. They need not be "divided." Cases should be supplied.

Holdalls.—It would be convenient to have places for pencils, brushes and drawing pens in these holdalls.

Levels (Abney's).—Improved pattern recommended—with slow motion screw and telescope.

Rulers, parallel.—There should be one large one, 18" or 12", of the rolling pattern. This may be intended, but it is not so specified.

Scales.—Stiff leather cases to hold 2 scales each should be provided—say 10 cases.

Magnetic trough-compasses (for Plane-Tables).—Should be those in wooden boxes with slide lids, length 6". The leather sling case is also sometimes useful. But the metal box trough compasses with outside clamp should be altogether condemned.

Sight-Rules.—Those for 18" × 24" plane-tables should have small cross levels let into the middle of the upper surface. Those for 18" × 18" plane-tables might have small circular levels similarly inserted. One edge of each sight-rule should be divided to a feet scale for 1 inch = 1 mile; the other to a yard scale for $\frac{1}{2}$ inch = 1 mile. I am aware that it is not usual to insert levels on sight-rules; but I have found that inexperienced plane-tablers consider them of great assistance. It must be remembered also that in the kind of work often necessarily undertaken by Survey Sections the plane-table has frequently to be used for extension for considerable distances without any aid from the theodolite; so that every small gain in accuracy is important,

Tables, plane, 18" × 18"—4.—I would recommend this number being at least doubled. They are extremely handy for rapid work, especially if the surveyor is mounted. The saddle attachment should be specified and provided. For the larger plane-tables I would recommend carbine buckets being provided and also arm-slings in order to facilitate their carriage by mounted surveyors.

All plane-table covers should be of "Willesden Canvas" with leather corners, and *sewn by a saddler* or sailmaker not by a tailor.

Spare Screws.—Should be provided for all plane-tables, not only for the smaller kind—as specified.

Theodolites.—I would recommend stadia wires to be provided for all theodolites and also extra levels attached to the *telescopes*; so that the instruments may be used for levelling, if required. Micrometer-microscopes should be provided on only one if indeed on either of the 5" theodolites. Such niceties are not adapted for active service. On service the essentials are—powerful telescopes, strength, simplicity and portability.

Tapes, Steel—300 *ft.*—Specify $\frac{1}{8}$" toughened steel. I would recommend at least 2 of these to be supplied and preferably even more.

Lanterns, camp—2.—I would suggest that *at least* 6 of these should be provided. Allowance must be made for the surveyors being scattered and camped in pairs for considerable periods. It is very important to provide an effective light at night, so that penning in and tracing may be carried on then and preparations made for the next morning.

Umbrellas, "gig."—The specification should surely be "Survey" or "Sketching." A "gig" umbrella is much too heavy.

Weights, leaden—for papers.—Unnecessary luxuries.

Books.—I would suggest—Angle Books 12, Astronomical Observation Books 6, Logarithm Tables—at least 1 each of Shortrede's, Chambers' and Bottomley's, also 1 or 2 copies of the S.M.E. "Reconnaissance Tables." All books should be bound in plain leather, and Almanacs, Forms, Note or Memorandum Books, etc., in strong canvas.

Chalks.—Should be Chalk Pencils—"Creta Laevis" is the best, as supplied by Artists' Colourmen—not Stationery Department.

Colours.—If colours must be used for field-sheets, then Higgin's indelible inks should be used. These stand rain quite well, whereas ordinary water-colours do not. Those colours should be selected which will photograph best—in case a rapid copy of the field-sheet is urgently required. Vermilion, Chrome Yellow, *Prussian Blue* used fairly thick intercept or absorb a good deal of light. Experiments should be made with various greens. "Emerald Green" will probably be the best.

I am strongly of opinion that it is most important that the field-sheet should be penned in in such a way that it may be suitable for photographic reproduction on emergency. To this end the best method is of course to pen in entirely in black, as is done always on the Survey of India. I do not see any objection to this—except that more skill and care is required on the part of the surveyor. If this suggestion is not approved, then the colours should be chosen as above suggested; but, even so, good results cannot be expected when rapid reproduction is required.

The "cakes" of water-colours specified are at all events unsuitable for the field. Gamboge and Prussian Blue soon break up. Pans should be used. Also, I would suggest a made-up green, *e.g.*, "Hooker's No. 2," for the sake of uniformity, instead of Yellow Ochre, and for reasons above stated Vermilion instead of Crimson Lake and Chrome No. 2 instead of Gamboge.

Paper, drawing.—The allowance seems rather small—1½ quires.

I would recommend the "Not" surface for field work, as it stands handling, rubbing and weather better than the "hot pressed" surface.

Pens—mapping—Cards.—6 only. These are the pens most men prefer for field work. At least 2 dozen cards should be provided. I refer to the small barrel-shaped "steel crow quills" usually supplied on cards.

Other minor articles I would suggest as essential are:—glue and glue-pot, muslin for mounting plane-tables, starch or flour for paste, paste brushes, and brown paper—large sheets.

I would also recommend the following articles of equipment not specified in the above list, viz.:—

Range Finders.—2 at least—pattern most suitable and giving best results to be selected.

Drawing Boards.—2 ft. × 3 ft., with cross battens on underside and folding trestle legs to form tables when necessary.

Tents.—As before stated allowance must be made for surveyors being detached singly or in pairs. I think a "tente d'abris" at least should be provided for each surveyor and perhaps for each batman. Tents are, I see, provided for the Mapping Detachment. Officers should also be provided with small tents. It is impossible to compute, prepare plane-tables, compare edges, etc., in the open, except under extraordinarily favourable circumstances. The smith and drivers could sleep in or under the carts, and probably the batmen also,—generally; as, presumably tarpaulins or cart-covers are provided.

All tents should have jointed bamboo poles; so that they may be easily carried on pack animals.

MAPPING EQUIPMENT AND STORES.

(Authorised List for a Survey Section).

FIELD LITHO EQUIPMENT "NO. 1" (FOR CART TRANSPORT).

Details of Boxes.

No. of Box.	Detail of Stores.	Quantity.	Weight of Stores.		Total Weight of Stores.		Weight of Chests.		Total Weight.	
			lbs.	ozs.	lbs.	ozs.	lbs.	ozs.	lbs.	ozs.
1	Litho press, No. 1, complete	1	305	—	305	—	96	8	401	8
2	Stones, litho, double-faced :— $23\frac{1}{2}'' \times 18\frac{1}{2}'' \times 2\frac{1}{4}''$	2	160	—	160	—	66	—	226	
3	Do. do. do.	2	160	—	160	—	66	—	226	
4	Calico, white, dressed	50 yds.	15	4						
	Paper, blotting	5 qrs.	6	8						
	,, white, demy	4 rms.	104	—						
	,, litho transfer, tracing, demy	$2\frac{1}{2}$ qrs.	—	$11\frac{1}{2}$						
	,, chalk, red. demy	1 qr.	1							
	,, litho transfer, writing, demy	$2\frac{1}{2}$ qrs.	4	0						
	,, tracing, demy	$2\frac{1}{2}$ qrs.	1	8	132	$15\frac{1}{4}$	48	—	180	$15\frac{1}{4}$
5	Acid, citric	—	1	—						
	Basins, evaporating	2	—	$9\frac{3}{4}$						
	Brushes, camel hair, No. 5 size	4	—	1						
	,, sable ,, No. 1 ,,	4	—	—						
	Cans, oil, lubricating, G.S.	1	—	6						
	Cotton waste, white	2 lbs.	2	—						
	Drivers, screw, general service, 9"	1	—	$12\frac{1}{2}$						
	Glass paper, No. $2\frac{1}{2}$	12 shts.	1	6						
	Gum Arabic	2 lbs.	2	—						
	Flour	4 ,,	4	—						
	Handles for rollers, lithographic, 11"	1 pair	—	1						
	India rubber	2 pieces	—	1						
	Ink, litho print, black, 1-lb. tins	2 tins	2	6						
	,, ,, green, ,,	1 ,,	1	3						
	,, ,, red, ,,	1 ,,	1	3						
	,, ,, sienna, ,,	1 ,,	1	3						
	,, ,, blue, ,,	1 ,,	1	3						
	,, ,, re-transfer, $\frac{1}{4}$ lb. tins	1 ,,	—	5						
	,, ,, transfer writing	2 sticks	—	2						
	,, writing, black, 1 pint	1 bot.	2	13						
	Instruments, drawing, boxes of, G.S., filled	1 box	1	8						
	Knife, office	1	—	1						
	,, scraping	1	—	2						
	,, palette, 12"	1	—	6						
	,, paper	1	—	7						
	Pencils, lead, H.H.H.	6	—	$1\frac{1}{2}$						
	Pens, mapping	3 doz.	—	1						
	Penholders	1 ,,	—	$1\frac{3}{4}$						
	Pen, nibs, medium	1 box	—	$1\frac{1}{4}$						
	Plate, inking, 20" × 15"	1	9	9						
	Rollers, litho, 11"	1	10	—						
	Rulers, rolling, 18"	1	3	3						
	Saucers, ink, 3" diameter	6	—	7						
	Scissors, paperhangers'	1	—	5						
	Sponges, $\frac{3}{4}$-oz.	6	—	$4\frac{1}{2}$						
	Stone, snake, slips	2	—	1	49	$6\frac{1}{2}$	76	—	125	$6\frac{1}{2}$

Details of Boxes—Cont.

No. of Box.	Detail of Stores.	Quantity.	Weight of Stores.		Total Weight of Stores.		Weight of Chests.		Total Weight.	
			lbs.	ozs.	lbs.	ozs.	lbs.	ozs.	lbs.	ozs.
6	Aprons, white	2	1	1¼						
	Acid, nitric, commercial	24 ozs.	2	13						
	Bucket, water, G.S., leather	1	4	11¼						
	Canvas, screen	12 yds.	2	12						
	Cloth, collar, white, 36" wide	1 ,,	1	0						
	Kettle, copper, 3 pints	1	1	14						
	Oil, lubricating	1 qt.	2	12						
	Stone, grit	1 piece	5	12						
	,, snake	1 ,,	4	9						
	Turpentine, spirits of	2 gall.	23	0	53	2½	68	0	121	2½
	Varnish, litho, middle	1 qt.	2	14						
	Tent, telegraph	—	—	—	100	—	—	—	100	
							Total Weight		1381	

FIELD LITHO EQUIPMENT No. 2 (FOR PACK TRANSPORT OR LIGHT CART).

Details of Cases.

No. of Case.	Article.	Weight.		Total Weight.	
		lbs.	ozs.	lbs.	ozs.
1	Cotton, waste, white (1 lb.)	1	0		
	Ink, lithographic, printing, black, tins (1)	1	3		
	,, ,, ,, blue ,,		9		
	,, ,, ,, green ,,		9		
	,, ,, transfer, writing, sticks (2)		2		
	,, ,, printing, red, tins (1)		9		
	,, ,, re-transfer, ¼ lb. tins (1)		5		
	,, ,, printing, sienna, tins (1)		9		
	,, writing, black, bottles (1)		4		
	Muller, 2-inch	1	8		
	Paper, white, foolscap (1 ream)	14	0		
	Plates, lithographic, zinc, 17" × 14" (12)	28	4		
	Rollers, lithographic, 11-inch (3)	10	0		
	Sand, grey	6	0		
	Case for above ("tool, squadron, leather")	17	0	81	14
2	Carriage, block and bar with leather strap	64	0		
	Case for above ("tool, squadron, leather")	17	0	81	0
3	Bars	2	0		
	Cylinder	14	0		
	Eccentric shaft	5	0		
	Handle	3	0		
	Lever	4	0		
	Side frame of press (handle side)	36	4		
	Case for above ("tool, squadron, leather")	17	0	81	4

Details of Cases—Cont.

No. of Case.	Article.	Weight. lbs.	Weight. ozs.	Total Weight. lbs.	Total Weight. ozs.
4	Drivers, screw, general service, 9″		12½		
	Flour	2	0		
	Gall, solution	2	14		
	Gum Arabic	2	14		
	Paper, white, foolscap, reams (1)	14	0		
	Saucers, ink, 3″ diameter		7		
	Scraper box, scraper, crosshead, pressure screw and spanner	27	0		
	Sponges, ¾-oz (6)		4½		
	Turpentine, spirits of (1 gall.)	11	8		
	Varnish, litho, middle (1 quart)	2	14		
	Case for above ("tool, squadron, leather")	17	0	81	10
5	Acid, citric		8		
	Aprons, white	1	1½		
	Basins, evaporating (2)		9¾		
	Box, drawing instruments, G.S., filled (1 box)	1	8		
	Brushes { camel hair, No. 5 size (4) / sable hair, No. 1 size (4) }		1		
	Bucket, water, G.S., leather	4	11¼		
	Calico, white, dressed (20 yards)	6	2		
	Can, oil, lubricating, G.S.		6		
	Canvas, screen	2	12		
	Cloth, collar, white, 36″ wide	1	0		
	Galls, Aleppo, whole		8		
	Gum Arabic	1	0		
	India rubber, eraser (1 piece)		½		
	Knife, office		1		
	,, palette, 12-inch		6		
	,, paper		7		
	,, scraping		2		
	Paper, glass, No. 2½ (sheets 12)	1	6		
	,, blotting (1½ quires)	2	0		
	,, tracing, red, foolscap		1¼		
	,, chalk red, foolscap (1 quire)		5		
	,, transfer—tracing, foolscap (2½ quires)		6½		
	Pen nibs, medium (1 box)		1¼		
	Pens, mapping (3 cards)		1		
	Pencils, lead, H.H.H. (2)		½		
	Penholders (1 doz.)		1¾		
	Potash, caustic (sticks)	1	0		
	Roller, lithographic, 11-inch:—Handles (1 pair)		1		
	Rulers, rolling, 15-inch	1	0		
	Scissors, paperhangers'		5		
	Side frame of press	35	12		
	Case for above ("tool, squadron, leather")	17	0	80	13
	Tent, telegraph (1)	100	0	100	0
	Total Weight			506	9

The Field Litho Press No. 1 prints a sheet 18″ × 23″, No. 2 a sheet 13″ × 14″. There has been prepared besides these two a third pattern, "Field Litho Press No. 3," still smaller, for pack transport only. This weighs only about 160 lbs. and can be carried on one mule. It prints a sheet 14″ × 9″ ("foolscap" size). Remarks on Authorised Field Litho Equipment, etc.

These types of Field Litho Press have been very carefully worked out; but, I doubt if it will be found advisable to take lithographic stones on service in the field. They are very heavy and very easily broken. Undoubtedly stones are easier to work than plates and give better results—especially in hot climates; but, it is probable that expeditions in hot countries will require as light an equipment as possible; so that it will be impossible to use stones under the circumstances in which their superiority is most apparent. I think therefore that stones should be thrown out of the field equipment altogether. After all, with care and experience zinc plates will always give sufficiently good results—certainly with a hand-press. There is moreover to be considered the fact that a dozen or more plates can be carried for one stone.

I believe also, as I have already stated in this article (page 283), that it is very important to provide Survey Sections with some more rapid means of putting their field work in a form adapted for reproduction than by tracing-transfer, as at present proposed; and, if weight were saved by substituting plates for stones, apparatus for photo-process reproduction could be provided without much increasing the total weight of the equipment.

The additional equipment I would propose would be roughly as follows:—

Photo-process Equipment.

1 *Process Camera* (size adapted for normal field-sheet or for *half* such field-sheet).
5 dozen Process Plates, ditto, ditto.
2 Printing Frames (in cases), ditto, ditto.
1 Special Printing Frame for Vandyke Process, with spare glass, in padded cases (size adapted for normal field-sheet).
1 Small Oil Stove, with supply of oil in cans.
2 Lamps or Lanterns in boxes and 1 Lamp for developing.
1 Small "Dark" Tent with fittings complete, jointed bamboo poles.
Small Stores for photographic and process work, baths, etc.
Chemicals, etc., „ „ „ tabloid form.

"Sun-printing" Equipment.

2 Printing Frames, in special padded cases (size adapted for taking two field-sheets side by side).
5 Rolls Ferro-Prussiate Paper (French), "rapid."
5 „ Bemrose „ No. 4.
1 „ Calico for mounting Bemrose paper for use in field.
Chemicals (crystals) for sensitising paper for Ferro-Prussiate process.
Small Stores „ „ „ „
Baths, etc.

Map Linen or Pegamoid.

There appears to be no provision of any durable material for printing maps on for use in the field. All maps for this purpose should be printed on thin "Pegamoid" or other similarly prepared linen. The only

satisfactory substitute is specially prepared thin tough paper. This has the advantages of being cheaper and lighter and easier to print on; but it is not nearly so durable as "Pegamoid." Four or five reams at least of "Pegamoid" should be taken if any considerable amount of map printing is anticipated. Though difficult to manage in a "machine," linen is easy to handle in a "hand-press."

Camera for Reconnaissance Work.

I would suggest also that a good hand camera, taking a long "panoramic" plate and with a special wide angle lens, should be provided for occasional reconnaissances. One of the officers and one or two of the N.C.O.s or men might be trained to use it and to develop and print from the plates. The space required for accessories, viz., plates, ruby lamp, celluloid baths, measuring glasses and chemicals, which latter might all be in tabloid form, would be inconsiderable.

Ueber Kriegführung im Hochgebirge, von Major C. de Perrot. (Bern).

Die deutsche Land-und Seemacht und die Berufspflichten des Offiziers, von Hauptmann v. Rabenau. (6,25 mks. Mittler & Sohn, Berlin).

Modern Buildings. Their Planning, Construction, and Equipment. Edited by G. A. T. Middleton, Vice-President, Society of Architects. Vol. I. (12 × 9. 10s. 6d. Caxton Publishing Company).

Cassell's Building Construction, by Prof. Henry Adams, Examiner to the Board of Education. (9⅓ × 6½. 7s. 6d. Cassell).

The Energy Chart. Practical Applications to Reciprocating Steam Engines, by Capt. H. R. Sankey, late R.E. (7½ × 5½. 10s. 6d. Frost & Sons, Rugby).

Modern Turbine Practice and Water-Power Plants, by J. W. Thurso. (16s. Constable).

Motor Vehicles and Motors, by W. Worby Beaumont. Vol. II. (11 × 8. 42s. Constable).

La Navigation Sous-Marine, par G.-L. Pesce. (12 × 8½. 10 frs. Vuibert et Nony, Paris).

Les Progrès de l'Aviation par le Vol Plané, par Capt. Faber. (8vo. 1·80 frs. Berger-Levrault, Paris).

The Forester. A Practical Treatise on British Forestry and Arboriculture for Landowners, Land Agents, and Foresters, by John Nisbett. 2 vols. (42s. Blackwood).

Industrial Efficiency. A Comparative Study of Industrial Life in England, Germany, and America, by T. Muir. 2 vols. (26s. Longmans, Green).

The Nile Quest. A Record of the Exploration of the Nile and its Basin, by Sir Harry Johnston, G.C.M.G., C.B. (9 × 6. 7s. 6d. Alston Rivers).

The Making of Modern Egypt, by Sir Auckland Colvin, K.C.S.I., K.C.M.G. (9 × 6. 18s. Seeley).

The Life of Sir Richard Burton, by Thomas Wright. 2 vols. (25s. Everett).

At the Gates of the East, by Lieut.-Col. J. P. Barry. (9 × 6. 6s. Longmans, Green).

Sporting Trips of a Subaltern. Big Game in India, Somaliland, Nigeria, by Capt. B. R. M. Glossop. (9 × 6. 10s. 6d. Harper).

Guns and Game: or Moor, Forest, Field, and Covert, by E. G. Mackenzie. (7½ × 5. 5s. Everett).

RECENT PUBLICATIONS.

Instructions for Practice: Horse, Field, and Heavy Artillery. Official. (6d. Wyman).

The British Army under Wellington, 1811—1813, by T. Miller Maguire, LL.D. (9×6. 6s. Clowes).

Guide to Military History for Military Examinations. Part II. Peninsular War, 1811—1813, by Capt. G. P. A. Phillips. (7×5. 3s. Gale & Polden).

The Peninsular War. March 1st, 1811, *to October 31st*, 1813, by J. H. Anderson. (9×6. 3s. Rees).

Story of the Campaigns in the Peninsula: Part II., from 1811 *to the end of* 1813, by Lieut.-Col. H. M. E. Brunker. ($7\frac{1}{2}$×5. 7s. 6d. Forster Groom).

Military History for Examinations in 1906–07. *Questions on the Campaigns in the Peninsula in* 1811–1812 *and* 1813, by Lieut.-Col. H. M. E. Brunker. ($7\frac{1}{2}$×5. 1s. Forster Groom).

The Salamanca Campaign, by Capt. A. H. Marindin. (11×10. 7s. 6d. Rees).

Le Coup de Grâce: Epilogue de la Guerre Franco-Allemande dans l'Est, par Gén. de Piépape. (8vo. 8 frs. Plon-Nourrit, Paris).

Die Kämpfe der deutschen Truppen in Südwestafrika. Heft 1. v. Grosser Generalstab. (8vo. Berlin).

Port Arthur: The Siege and Capitulation, by Ellis Ashmead-Bartlett. (9×6. 21s. Blackwood).

From the Yalu to Port Arthur, by W. Maxwell. (9×$5\frac{1}{2}$. 16s. Hutchinson).

Le Monde et la Guerre Russo-Japonaise, par A. Chéradame. (8vo. Paris).

Origines et Résultats de la Guerre Russo-Japonaise, par R. Pinon. (8vo. 5 frs. Perrin, Paris).

With the Cossacks. The Story of an Irishman who rode with the Cossacks throughout the Russo-Japanese War, by F. McCullagh. (9×6. 7s. 6d. Nash).

Die Erziehung der Truppe zum moralischen Wert in Deutschland, Russland, und Japan. Eine vergleichende Studie auf Grund des russisch-japanischen Krieges, von Hauptmann H. Muller. (1,75 mks. Oldenburg).

Küstenschutz und Unternehmungen gegen dasselben auf den Schleswig-Holsteinisch-Jübischen nord und Osterküste im Feldzug, 1864, von Colonel Cardinal v. Widdern. (2 mks. Eisenschmiat, Berlin).

But it is not only against rifle bullets that head cover and over head cover are useful, but most particularly against the modern shrapnel. Since it is the object of the guns of the attack to keep the defenders' heads down, it is only by giving adequate protection that we can hope to keep them up. Tufts of grass or bushes to hide heads are of course very desirable, and better than nothing, but where material and time is available something stronger should be attempted. The statement that "At ranges at which a man's head would be visible, men firing over a parapet, with their heads merely concealed from the enemy's view, will probably not suffer more than the same number of men firing through clearly seen loopholes" requires proof; it depends on the class of loophole made and on whether the fire is direct or oblique.

Yours faithfully,

G. M. HEATH,

Lieut.-Colonel.

The Editor, "R.E. Journal."

But besides open ground another condition is essential to stay the attack, and that is good shooting on the part of the defender; and this good shooting depends very greatly on the amount of covering fire the attacking artillery and infantry are able to develop. If this supporting fire is as good as it should be, and if the defenders have not had time to make head cover or over-head cover, the attacking infantry may, even over open ground, get close up to the trenches without serious loss. But this covering fire has to cease sooner or later according to the configuration of the ground, and it is then the defender gets his chance. To defeat this chance it is the aim of the attack to bring an overwhelming force to within charging distance. The 200 yards of dead ground permitted by Colonel Capper should enormously facilitate this final stage, making as it does a convenient breathing place before assault.

Had there been this zone of safety in the instances quoted above, is it not at least possible that the attack in each case would have got home?

At Talana, Belmont, Graspan, Alemand's Nek and many of the earlier battles of the Boer War the ground immediately in front of the Boer positions gave fair cover and anxiety on our side was pretty well over when that ground was reached.

The best site for a fire trench is often a debatable point; for the circumstances of tactics, ground, morale, and fire effect vary so much that only experience can decide on the best position in each case. But I maintain—in fighting a civilized enemy at any rate—one principle should be that, if the contour of the ground involves 'dead' ground immediately in front of a trench, this dead ground must "not only at night and in misty weather" but in all cases be swept from another position. In fact the principles laid down in *Manual of Military Engineering*, Sections 1 and 66, and in *Instruction in Military Engineering*, Part I., paras. 132 to 136 must be applied—with common sense.

Coming to 'concealment' it seems to me doubtful whether at "very close ranges" the *defending firing line*, unless very weak and extended, will gain much protection from mere bushes, for the concealment of a position at very close ranges is hardly possible. The attacking fire at these very close ranges is likely to be anything but aimed. There should at this stage be a storm of attacker's bullets sweeping the defended area, a great many of which will find their billets unless the defender is covered by something more bullet-proof than a hedge. The instance quoted by Colonel Capper where the Boers attacked a few men in some outlying trenches does not seem to be quite applicable to the case under discussion. These Boers were attacking and had got up to close range through scrub at night; their position then could not definitely be known. It was a case of a few men on an extended front.

Colonel Capper seems to me to rather deprecate the use of loopholes and gives good reasons, but if there is one thing we Engineers have learnt from the late war it is the importance of head cover and over-head cover. At Port Arthur the Russians at first made open trenches, but they soon found that over-head cover was essential. Miles of it were made, and many of the positions so defended were held against very strenuous attack. Both sides found head cover a necessity at close ranges.

NOTES ON SHELTER TRENCHES.

SIR,

There are a few points in Colonel Capper's able "Notes on Shelter Trenches," published in the March number of this *Journal*, which seem to require further discussion.

In the preface to the *Manual of Military Engineering*, 1905, are the following words:—

"Officers and N.C. Officers in charge of works should, while bearing the principles in mind, learn to modify the types according to local conditions."

Now the principles running through this book are many, and the first is—that the position to be defended must be chosen with regard to 'tactical requirements.' It seems to me that, if this rule is assimilated, no officer, when arranging a rear-guard action, will place his men in a position from which they cannot be retired. If rules are required for all and every occasion the text-books, already fat enough, would become quite corpulent,—something must be left to teaching and to reason. 'Intelligence' even 'untaught' would in the circumstances cited by Colonel Capper have done the 'obvious' thing in practice. It was the imagination required for the good working out of an imaginary situation that was lacking. The man without intelligence, taught or untaught, will go wrong sooner or later, however many rules have been laid down. For such the text-books cannot legislate.

Colonel Capper's contention that "if the attack is able to advance over *open ground* to within a very short distance of the trenches he will *in all probability** be successful" is without doubt borne out by facts, for most unsuccessful attacks over such ground both in the South African and (apparently) in the Russo-Japanese War fizzled out at, say, 800 yards from the trenches. But the italics are important; probabilities are not good enough where principles have to be laid down. A good many instances can be found where attacks over open ground failed in the last 200 or 300 yards. At Paardeberg half a battalion of the Duke of Cornwall's Light Infantry and, I think, some of the Seaforth Highlanders attacked over fairly open ground, and were stopped only 200 yards from the Boer trenches. At Nanshan the Japanese got to within 200 yards of the Russians and then made several unsuccessful charges, officers and men falling within 20 and 30 yards of the enemy. At Shu-shan-pu (south of Lioa-yang) there was more than one instance where the Japanese got close up and then failed. In the attack of one of the redoubts round Liao-yang the Japanese infantry, attacking over open ground, got to within 200 yards, and there had to wait till night before the final assault could be made.

The fact is the expression 'open ground' is indefinite. So-called open ground is often deceptive, and affords a good deal of cover to skilful men where the casual eye would say none existed.

* These italics are mine.

CORRESPONDENCE.

OUR IDEAS ON PERMANENT FORTIFICATION.

DEAR SIR,

I write to thank Capt. G. Walker for his friendly criticisms in the last number on my article in the January issue, and to a certain extent make a short reply to them.

I must say that I started my article with the idea that our ideas were in some respects wrong, but I think my article shows that I modified my opinion.

As to the plans generally I came to the conclusion, when I had finished them, that they were a very unsatisfactory solution of the problems I had set before myself; but rather than throw away the results of some three weeks' work I let the whole article stand, in order, as Capt. Walker remarks, "to induce others to take a hand in the discussion." I wish some R.E. officer, who is on leave or has some leisure, would design a type fort or redoubt and let us have the result.

I quite agree, now, with Capt. Walker that electric lights should not be placed in the works but in flank positions, which should be changed from time to time; otherwise the electric lights will only serve as guides to assaulting parties.

Perhaps what the Corps really wants is a "Manual of Permanent Fortification," which should be divided into at least two volumes and brought up to date from time to time. There are official manuals on almost every duty nowadays. Why should there not be one on this important subject, which has fallen so greatly into neglect of late? Colonel Lewis's invaluable book would form a very sure foundation on which the official edifice might be built.

Yours truly,

H. E. G. CLAYTON,

Major, R.E.

The Editor, "R.E. Journal."

Now the hydroplane is merely a boat to which is attached a series of planes placed at convenient inclinations. At the commencement of the movement the pressure of the water on the apparatus and its retardation are at a maximum. But it has scarcely commenced to move when an ascending movement also commences, which — if the velocity is sufficient — is not arrested until it has regained a position in which, as long as it is acted upon, the retardation becomes decreased and finally annulled. In Count di Lambert's boat the inventor calculates that the ascending movement is complete when it reaches a velocity of 15 k.m. Beyond this limit the force necessary for the propulsion of the emersed hydroplane increases exactly as the velocity. This however is only as long as the velocity does not become very great, since the resistance of the air is not taken into account. To obtain the given speed of 15 k.m. for the boat in question a 6-h.p. motor is used; from which the speed of a boat provided with a motor of 40 h.p. is calculated to be 100 k.m. an hour. This value is subject to a large reduction owing to the resistance of the air. The Archdeacon, after combating the objections that it would be difficult for a hydroplane to move in water not perfectly smooth, gives drawings and explanations of the method of arranging the planes, of their position in the boat, and of the method of supporting the propellers, etc.

E. T. THACKERAY.

Generals Mischensko and Kondratovisch—and 400 other officers. After the battle there were found at Mukden about 8,400 wounded men, but the number of men killed, of wounded recovered from the Japanese, and of prisoners is not known. From all the information obtainable it may be deduced that the total loss of the Russians amounted to about 13,000 men. The effective force employed by the 2nd Russian Army was limited to the 1st Siberian Corps, the Mixed Corps, and the 14th Division, calculated at about 52,000 men, to which may be added about 6,000 men of Mistchensko's cavalry. The losses were thus about 24 per cent., a notable proportion. The causes were probably—dense formations, the difficulty of obtaining cover owing to the hardness of the ground, distinct visibility at a distance owing to the snow, and lastly climatic conditions.

The losses of the Japanese, according to reliable data, amounted to 9,400 killed, wounded, and missing, among whom were 353 officers. Since the force consisted of two entire divisions (8th and 5th), a reserve brigade, and a cavalry brigade, there was a total of about 40,000 men engaged; so that the proportion of their losses was also about 24 per cent., this figure being an increase over the losses sustained in previous battles, owing (among other causes) to the climatic conditions and to the obstinate resistance opposed by an enemy superior in numbers.

THE FUTURE OF HYDROPLANES.—*La Vie Automibile* of 23rd December, 1905, contains the following ideas of Sigr. Erneste Archdeacon on the construction of the apparatus called the hydroplane.

The constructors have long been aware of the great difficulties that are met with in increasing the velocity of boats, owing to the resistance of the water, and because the force required for propulsion increases in boats of the ordinary form in the ratio of the cube of the velocity. During late years they have succeeded in considerably increasing the velocity of automobile boats by making them of a less fishlike form, so that while the velocity is increased the resistance of the water is much less than before. It is calculated that in boats of the latest model, by diminishing the fishlike structure, the retardation caused by the resistance of the water may be diminished 33 per cent. Two years ago the Count di Lambert succeeded in constructing a boat by which the resistance of the water was not only reduced 33 per cent. but was so completely suppressed that it scarcely offered any resistance.

The principle that guided the construction with such a result is stated to have been discovered many years ago by Mons. Pictet of Geneva, who experimented on the lake of Geneva with boats the framework of which was provided with inclined planes. The boat constructed by di Lambert, although it is heavy and in some respects defective, is capable of attaining a speed of 35 k.m. an hour with a motor of 13 h.p.

The theory of the hydroplane is in other respects similar to that of the aeroplane, and is based on the fact that, whatever may be the inclination of the planes, it remains horizontal in a fluid—air or water—subject to an ascending or descending reaction in regard to the forward movement.

observations of the enemy's aeronauts. Two balloon companies were attached to the newly-formed battalions; and the third was the balloon company of Eastern Siberia which had previously been stationed in the theatre of war. The Japanese fired at the balloons with shrapnel and shells provided with time fuzes, but without result according to the Russian accounts. Some ascents were made by the Russian balloonists, even at night time, but the officers engaged assert that these ascents were made under great difficulty owing to the low temperature. Photographs of the balloons in use by the Russians are shown at p. 18.

The Japanese at this time did not make use of balloons; they carried on their observations of the enemy's positions from observatories established in the villages, from trees, or from any eminences in the plains. From these observatories very important vigilance was exercised. Flag signalling was carried on from these posts by day. By night the electric light was used, with coloured light, on a system similar to that in use by the navy.

At this time several small skirmishes took place between the advanced guards and the isolated patrols in front of the Hun as far as Biamupusa, in which locality there had been combats of some importance at the end of 1904 between the troops of the more advanced detachments. The Japanese battalions were disposed with only three companies in the lines of the trenches, the fourth being located behind a village during the day but brought to the front at night. By day each battalion was covered by sentries placed in elevated observatories and by night by watching patrols. If the Russians were not seen, notice of their approach was given by the baying of a dog which was always kept at a small post in the vicinity. On discovering the patrols the alarm was given by whistles or rifle shots.

Battle of Sandepu.—The battle of Sandepu lasted from the 25th to the 29th January without interruption in the midst of a snowstorm, the temperature which followed the mild period from the 5th to the 20th January being very low at this time. The battle commenced by an attack made by the right of the 2nd Russian Army Corps, during which the enemy, taken by surprise, had to abandon their more advanced positions. This was followed by a vigorous counter-attack by the Japanese, which paralysed the Russian movement. The Russians then remained in this position for three days, from the 26th to the 28th, during which an uninterrupted series of local combats took place, ending by orders from superior authority being received on the evening of the 28th for the retreat of Grippenberg's army.

The Japanese forces engaged in this battle, according to approximate calculations, amounted to about 40,000, against 58,000 Russians. But the first day (the 25th) there were about 3,000 rifles scattered in the villages, which had before them at a very little distance the Siberian Corps on the west and north and the 14th Division with 30,000 rifles and 14 field batteries.

The losses suffered by the Russians in this disastrous battle were very great. According to Russian sources the total loss of officers killed, wounded, and prisoners amounted to 6 generals—among whom were

squadrons of light cavalry (two British and two Austrian) routed twice their number of French cavalry, and broke a square of six battalions.

PURSUIT OF THE ENGLISH ARMY BY MARSHAL SOULT.—The series of articles on Napoleon's campaign in the Peninsula is brought to a conclusion by the battle of Corunna. Commandant Balagny claims that the French had the best of the fight; but it was begun too late in the day, and the proportion of troops engaged was too small for any decisive success. At Corunna, as at Lugo, Soult showed himself too cautious, not to say timid. He had the excuse that he was inferior in numbers to the English, and their escape was mainly due to Napoleon's decision at Astorga not to send on Ney with Soult.

WAR OF 1870-1871.—*The Army of Chalons.*—Owing to the capture of a staff officer who was the bearer of fresh instructions from Macmahon, Failly's Corps pursued its march on Stenay, and came in collision at Nouart with the advanced guard of the Saxons on August 29th. After dark Failly turned his corps northward, and in the course of the night it reached Beaumont, but men and horses were utterly exhausted. To retreat on Mézières or to push on towards Metz seem to have been the only alternatives entertained by Macmahon. The writer suggests that a vigorous attack on the nearest German corps would have been better than an attempt to slip past them.

E. M. LLOYD.

RIVISTA DI ARTIGLIERIA E GENIO.

January, 1906.

RUSSO-JAPANESE WAR.—An article by Capitano d'artigliera Luigi Giannitrapani gives a general account of the operations in Manchuria in 1905 and of the strategy and tactics of the contending armies, and contains several technical matters of interest to the Engineer Corps of the two armies.

Field Kitchens.—The very rigid winter at the commencement of 1905 was one of the severest on record, the lowness of temperature being aggravated by severe dust and snow storms. The comparatively good sanitary conditions of the Russians during this period is ascribed to the use of field kitchens on wheels, by means of which hot rations could be served to the troops twice during the day, at dawn and sunset.

These field kitchens, capable of carrying about 200 rations, were of two kinds, one for infantry and the other for cavalry, the former on four wheels and the latter on two. A sketch of these field kitchen carriages is given on p. 16.

Balloons.—The Russians at this time—the early part of 1905—made use largely of balloons for observing the enemy's positions. Sometimes clouds of smoke were created by the Japanese in order to impede the

uniformly distributed over the target presented by a man's body, they come from all directions, front, rear, and flanks, so that a man presents a target proportional in area to the square of his height. The Anthropological Institute gives the average height of the Japanese soldiers as 1,585 millimètres as compared with an average of 1,642 millimètres of the Russian conscripts. The average targets offered by each to the enemy are, therefore, as the squares of 1,585 and 1,642, or as 100 to 108, an advantage to the Japanese of about 8 per cent.

W. E. WARRAND.

ORGAN DER MILITÄRWISSENSCHAFTLICHEN VEREINE.

No. 2, Vol. XXII.

MILITARY BALLOONS IN THE RUSSO-JAPANESE WAR.—The Russians had two types of balloon, spherical and elongated. The first was of French make and was of varnished material; the latter was made in Germany, the material being treated with rubber. The rubber material became hard and brittle in cold weather.

The elongated balloon was not steadier than the spherical and was too large to be man-handled in a strong wind. The winding engine for the cable had to be left behind as it was too heavy to be brought over the Manchurian roads. The French spherical balloon was much used. It was hit several times, once by a shrapnel, but only five small holes were made in it.

The Russians made their gas *in situ*. They first used scrap iron and sulphuric acid for generating the gas, but these were found to be too heavy so a lighter pattern of generator was adopted. In this the gas was made from aluminium and caustic soda. The charge for a balloon (spherical ?) was 600 cubic mètres of gas; and required either 2,200 kilos. of iron and 2,900 kilos. of sulphuric acid, or 550 kilos. of aluminium and 1,000 kilos. of caustic soda.

It was found almost impossible to observe shrapnel fire accurately from a balloon, but this difficulty did not occur with common shell.

The Japanese balloons were elongated and carried a three-cornered sail. The type was not satisfactory. During the siege of Port Arthur the Japanese balloons never came within 8,000 mètres of the fortress and consequently did not accomplish much.

J. E. E. CRASTER.

REVUE D'HISTOIRE.

February, 1906.

CAMPAIGN OF 1794.—*Army of the North.*—The progress of the siege of Landrecies and the attempts of the French to raise it are described. One of these attempts led to the action of Villers-en-Cauchie, where four

distilling with the same facility as water carried to 100° C. Palladium, iridium, and rhodium were also fused and distilled without difficulty.

THE INTRODUCTION OF REINFORCED CONCRETE (*p.* 350) marks a new epoch in the history of building. One of the most remarkable applications is its use for the construction of dams. This method of building a permanent masonry dam, at a comparatively low cost, has already rendered financially practicable the utilisation of many water-power sites which otherwise would have been neglected.

THE FIXATION OF NITROGEN (*p.* 355).—Sir William Crookes pointed out in 1898 that there will be a wheat famine in 50 years unless the world's yield per acre (at present about 12·7 bushels on the average) can be raised by use of fertilisers. Of such fertilisers the chief is nitrate of soda, exported from Chili, the supply of which at the present rate will be exhausted in less than 50 years. Then, the only chance of averting wheat starvation lies through the laboratory. Lord Rayleigh in 1895, by forming an arc between platinum poles, in an atmosphere of air to which oxygen had been added, and absorbing the oxide of nitrogen, formed by causing a fountain of caustic soda solution to play on the top of the flask containing the arc, produced a mixture of nitrate and nitrite of soda; the result being about 7 litres of mixed oxygen and nitrogen per hour; but no commercial process had been found practical for the synthesis of nitrates from the air till a Norwegian Company, in 1905, started a factory at Notodden, where the neighbouring waterfall now in course of utilisation will furnish 25,000 horse-power. The yield of nitric acid per year is said to be more than 500 kilograms for every kilowatt of power. The new product can now compete with Chili saltpetre on the market, and will become every year more valuable, as the demand for nitrates increase and the natural supplies become exhausted.

GRANULATIONS ON THE SOLAR SURFACE (*p.* 401).—An interesting research concerning the nature of the sun's photosphere has been instituted at the Pulkowa Observatory. Eight consecutive photographs with intervals of 15 to 30 seconds duration were taken. These show very plainly the changes taking place in the sizes and relative positions of the granules. The displacements of the granules in a few seconds were very diverse; some were found to be moving at the rate of 38 kilomètres per second, and some at the comparatively low velocity of 14 kilomètres per second. The dimensions of the granules varied greatly between 670 kilomètres and 2,000 kilomètres. These researches may lead to most important conclusions concerning the nature and the periodicity of the changes in the granules themselves, their influence on the solar spots and faculæ, and to the re-solution of many outstanding problems, concerning the nature and action of the photosphere, which are at present unsolved.

SOLDIERS' STATURE IN WAR (*p.* 414).—The Japanese had an unquestionable advantage in the recent war by being smaller than the Russians; they were smaller targets for firearms. Bullets are, on the average,

baulks available for road bearers measured 24 feet × 10 inches × 7 inches. With spans of 23 feet it was calculated that five road bearers would be sufficiently strong to carry field guns and moving infantry, the weight of the latter being taken as 60 lbs. per square foot. The baulks meeting over the saddle beams were bolted together in pairs, and one of each pair was bolted down to the saddle beam. The bridge was chessed with planks specially sawn in the Liao-yang railway workshops. The junks were moored up and down stream by 2-inch ropes to anchors or piles. A cut raft was prepared in the fairway near the left bank, and an ingenious arrangement was devised for breaking up the roadway to enable cut to be formed rapidly.

The breadth of the stream was 706 feet, and including the cut raft 35 junks were used in the bridge and 5 more were kept in reserve. The shore end on the right bank was trestled.

The bridge was built entirely by Sappers and Pontoniers and was finished in 12 days, but there was some delay both in making the bolts and in sawing the planks. The cost was 14,189 roubles, the junks being purchased at an average price of 200 roubles apiece.

Mention is made of a trestle bridge, of over 200 feet in length, across the Fan-tse, and of 16 other small trestle bridges of 70 feet and under. In the absence of planks suitable for chesses the roadway was made of light poles laid across the road bearers with bundles of kowliang straw laid on them and a layer of earth over all.

At Hai-cheng, on the river of that name, the Sappers made two bridges of trestles, as junks could not be brought up to the sites; no details are given of these bridges, except that some of the trestles were strengthened by being lashed with wire to piles driven in alongside. These bridges unfortunately had to be burnt two days after they were finished, owing to the retreat of the Russian army from Hai-cheng.

F. E. G. SKEY.

NATURE.

February, 1906.

THE GECKO (*p.* 322).—The Victorian *Naturalist* of December, 1905, mentions that the diamond-tailed Gecko (*Phyllurus platurus*) is always found head-downwards on the rocks it frequents. They assume this position, in order to make hawks believe that their heads are their tails; consequently, when seized by one of these birds, which invariably pounce upon what they regard as the head, the brittle tail snaps off, and the wily gecko wriggles away, little or none the worse for the encounter.

ELECTRIC FURNACE (*p.* 325).—Professor Moisen has continued his experiments on the fusion and volatilisation of the more refractory metals in the electric furnace. With a current of 700 ampères at 110 volts in 5 minutes platinum could be distilled with great ease, the liquid metal

A careful reconnaissance of the ground having already been made, the writer started work without delay on the 13th April, 1904; and with the help of an engineering staff of 2 officers and 32 N.C.O.s and sappers (which allowed, after deducting a small guard, about 1 officer and 8 N.C.O.s and men to each track) he was able to carry forward all three roads at the rate of two versts a day.

The work was of course carried out by Chinese coolies, who seem to have been rather unmanageable in large numbers. They were found to give better results when engaged individually (by the help of an interpreter) than through contractors, who probably defrauded them of half their earnings. They also not unreasonably objected to be paid in paper money. They were organised into parties for separate duties, such as tracing and cutting drains, building culverts and small bridges, cutting and spreading gaolana stalks, spreading earth and rolling. The cost of a verst of road, after experience had shown how it could be done most cheaply, worked out at between 50 and 80 roubles* according to the nature of the ground.

One feature of the country may be mentioned, the number of Chinese burial grounds, each containing about 20 tombs, for every family has its private cemetery. As there was every reason for conciliating the country folk as much as possible, it was generally arranged to divert the road so as to avoid these graveyards; but where, owing to the nature of the country, this was found to be impossible, compensation was arranged for at the rate of 3 roubles a tomb, a precedent for this having been established during the construction of the railway.

The writer was employed later on in constructing the military roads within the Liao-Yang defences, where a fairly complete system of communications seems to have been arranged. In this case it was found that Chinese labour was not available, all the Chinamen having been taken for work on the defences. Consequently military labour was employed; but this seems to have been an exception in the Russian army, and a special arrangement was made for the issue of working pay to the junior ranks.

In the portion of the article referring to bridging works a detailed description is given of a bridge built across the Tai-tse at Liao-yang The river was subject to floods and sudden changes of level, and a shifting sandy bottom made it unsuitable for trestle work, for which also the time and material available were insufficient. However junks were available in sufficient numbers and seem to have made very suitable substitutes for pontoons. These junks were about 26 feet long and 5 ft. 6 in. beam, and when unloaded the decks were about 3 feet above the water line. The writer calculates that their displacement, leaving a safe freeboard of 1 foot, was 600 poods or 21,975 lbs., but there are several misprints in the numbers quoted in the article and possibly this may be one.

The boats were overhauled and strengthened, especially in the bows, and improvised saddle beams were built up along the centre of each. The

* 1 rouble = 3s. 1d.

NOTICES OF MAGAZINES.

Cavalry Journal.

In the notice of the first number of the *Cavalry Journal* in our last issue, I omitted to mention that its Managing Editor, Lt.-Col. A. Leetham, late Captain, 13th Hussars, is a Sapper himself, being Major and Hon. Lieut.-Colonel in the Royal Monmouthshire R.E. Militia.

A. T. Moore.

Eenzhenernee Zhoornal.

July and August, 1905.

Road-Making and Bridging Work in Manchuria.—A short article mentions four sections of the road constructed by the Russians during the recent war under the superintendence of different officers:—(1) between Liao-yang and Mukden, (2) between Liao-yang and An-shan-chan, (3) between An-shan-chan and Hai-cheng, and (4) between Hai-cheng and Yen-kow. The author himself was responsible for the third, which he describes.

The existing mandarin road, a hollow way badly drained and presenting in most places a sea of clinging mud, was unsuitable for military purposes. The Russians took the precaution of making in its stead three almost parallel roads, one by the side of the mandarin road and in a few places coinciding with it, a second to the west of the first and near the railway, and a third to the west of the second. The distances between the roads varied from one to four versts.*

The soil of the country traversed by these roads was mostly stiff clay or sand, and the writer does not mention any rock-cutting difficulties. His attention was confined chiefly (1) to the cutting of a very thorough system of drainage, and (2) to strengthening the surface of the new roads, for which much use was made of the stout stalks of the kowliang—the high-growing corn which played such an important part in the tactics of the Manchurian battles. The latter arrangement was especially necessary where the road was to be used by country carts, as the large nail heads which projected from their tyres were particularly destructive to road surfaces.

The sections of the roads show them to have been from 16 to 23 feet wide, with ditches on both sides and very little camber.

* 1 verst = ·66 of a mile.

REVIEW.

RAPID STATICS.

By FRANCIS RUFF.—(5s.).

MESSRS. E. & F. SPON have published an English translation of the first volume of a small German publication entitled "Reference Book for Statical Calculations," which contains force-diagrams and tables, etc., 'for all classes of building and engineering, for the practical use of boards of works, architects and engineers.' The author, a civil engineer of Frankfort-on-Maine, claims this to be 'the first attempt to present in a comprehensive and easily graspable manner the applications of statics to the constructions most frequently appearing in technical work.'

After some preliminary explanations regarding moments of inertia and resistance to bending of the cross sections most commonly used, and of the transverse forces and moments of application for simple beams under concentrated and distributed loads, the book deals consecutively with various descriptions of:—Trussed beams; Strutted frames; Roof trusses; Cantilevers; Open Web girders; Curved beams; Suspension bridges; Framed columns; Earth pressure; Vaults; Reinforced concrete constructions. Then follow tables of moments of inertia and resistance to bending of the *German* standard sections, including pillars; and finally miscellaneous information such as weights of materials, minimum thickness of walls of houses according to height, number of rivets required for angle and flat irons.

The diagrams and letterpress are very clear, and many of the solutions, notably those of fish-belly girders and jointed arches, are extremely good.

Engineers must, however, be fully acquainted with the metric system before they can use this book with advantage, and it is therefore unlikely to become popular in this country. But Mr. Ruff contends that the use of the metric system for calculations saves much labour and reduces the risk of error; so that the introduction of his books may perhaps form one more argument in favour of this system.

The second volume of the above work, of which also an English translation is to be made, deals with Machinery.

P. O. G. USBORNE.

4. In fortress warfare traction engines and steam wagons may be used for transport of ammunition, supplies, and matériel, especially to outlying forts; also to work the dynamos of searchlights.

5. Motor cars and motor bicycles may be used, as already described, for conveying staff officers, carrying orders, reconnoitring, and similar purposes.

A wide field of utility is open to mechanical transport in war; and we may expect shortly to see it organized and developed, and taking its place in the ranks of the Army.

It is much to be desired that a thorough military test of motor wagons *at all seasons of the year* should be carried out. According to the newspapers, H.R.H. the Archduke Eugene was returning from the festivities attending the reception of the King of Spain in Vienna when his high-priced motor-car broke down on the high road between St. Polten and Melk. There was a light snowfall, and this was sufficient to choke the air-inlet valve. Such a car cannot be described as serviceable for war. A thorough military test of a vehicle must include its performance under all conditions of weather and at all seasons of the year.

We in Austria are on the right track. This is shown not by the motor-wagons which appear at our manœuvres, nor by the motor road trains which we have introduced at some stations for A.S.C. work, but by the remarkable progress made in the last two years by the Daimler company, working in harmony with our War Department.

An armoured motor-wagon carrying a Q.F. gun has lately been constructed by the above firm and tried in Austria, France, and Germany.

This wagon has a novel four-wheel drive, in which each wheel drives separately. The wheels are steel disc wheels with solid rubber tires. The hood over the motor, the radiator, and the driver's seat are armoured with steel plate. The driver sits in a steel cupola with a hole through which his head projects. But under fire he can lower his seat and his steering wheel, when he can see through eye-holes in the cupola.

At the back of the wagon is a hemi-spherical revolving steel turret containing a Q.F. gun. It is quite easy to load and fire the gun in any position.

This armoured wagon is said to travel 30 miles an hour. Its appearance is peculiar in that no driver is visible. Thanks to its four-wheel drive, it is capable (at least, so the makers claim) of running over all kinds of bad ground and of ascending slopes of 1 in 2, when the wagon appears to be on the point of overturning backwards. It is said to be capable of following anywhere where a field gun can go. This we beg leave to doubt.

In the present stage of development of the motor industry, motors may be usefully employed for the following purposes:—

1. Light covered wagons, built in military carriage factories, to replace hired transport for regimental provision wagons; also as ambulances, postal wagons, balloon and telegraph wagons, and Army Corps office wagons.

2. Motor wagons for the ammunition columns and train. This would shorten the columns very considerably and much facilitate supply service, and would also avoid the confusion and delay which results from putting in fresh echelons of hired transport every day. The shortening of the baggage train especially would be of the greatest advantage.

3. Motor wagons and traction engines for the lines of communication; the latter to be used only on good roads, where they will be of the greatest service. Both of these natures of transport may be used to connect the army with railhead, either of the permanent or the field railway; also to assist the field railway by doing part of its work.

when passing over weak bridges, fords, or short steep gradients, and hauled over with the wire rope and drum attachment.

One driver and one assistant are required for each wagon and trailers.

Thus we see that by using these wagons as road trains their useful load is trebled. For this reason all the great foreign firms—such as de Dion and Bouton, Scott, Thorneycroft, Serpollet, and Mercedes—are building so-called military tractor wagons, constructed to pull a load as well as to carry one.

It must be remembered that the petrol motor is still a delicate machine, requiring a skilful driver and a highly-trained mechanic to keep it in order. This is a defect from a military point of view, since it will not be easy to provide the requisite number of trained chauffeurs. To overcome this difficulty we are now training a number of soldiers at the Daimler factory in Vienna.

Medium motor wagons, of a type between the 2-ton (light) and 5-ton (heavy) are being built in France and Germany as field ambulances, field telegraph wagons, and field postal wagons. We are also experimenting in this direction. Thus at the last manœuvres we had two field post-wagons supplied by Wyner & Co. of Vienna. One was a two-cylinder motor of 12 H.P. and the other a single-cylinder motor of 8 H.P. The first was equipped with boxes for letters and parcels, and was used for postal service between the Army Corps and the railway stations. The second was used to distribute letters and parcels to the various units, and covered 30 to 40 miles a day.

Motor Cars.

These are constructed principally for speed. The same applies to motor bicycles. They are used for the rapid conveyance of officers, for reconnoitring, and for forwarding orders and despatches.

Motor cars are of many different types, and are driven by petrol, paraffin, steam, or electricity. Petrol motors are almost universally preferred.

Racing cars, manufactured only for sporting purposes, are built of 100 H.P. and over, and are capable of the speed of an express train. But for ordinary touring cars 20 to 30 miles an hour is not an unusual speed.

France is easily at the head of the motor-car industry; she is followed by England and America. Germany has now taken up this industry, and has at present over 100 motor-car factories.

Motor cars and motor bicycles are of considerable military importance. They will be of great service for reconnoitring and forwarding orders and reports. They have been thoroughly tested at manœuvres during the last few years, and the work done by them has met with general approval.

Motor wagons are by far the most important of these vehicles for military purposes. They have not yet been thoroughly tried at manœuvres, since the experiments to determine the best pattern have only just been concluded. But at the next manœuvres we may expect to see a large number of these motor wagons both singly and with trailers.

adhesion is sufficient to surmount steep gradients or roads slippery with ice. The road-speed may be taken at an average of 6·2 miles an hour. Any intelligent man can easily learn to drive a traction engine, especially since the machinery is simple and easy to clean and oil. These engines burn coal, coke, wood, or even peat.

The best traction engines are those made by Messrs. Fowler. These were used by the English in the South African War and did very well.

The principal objection to the traction engine is its great weight, namely 6 to 12 tons.

Traction engines require good roads and strong bridges. They therefore do not fulfil the conditions required of first-line transport. But they are well adapted for use on the road, especially on the lines of communication. They draw either two or three trucks, with a total useful load of from 12 to 24 tons.

But little attention is directed to the traction engine in modern armies, since the lighter motor wagon is better adapted to military purposes.

MOTOR WAGONS.

These are driven either by steam, paraffin, petrol, alcohol, or electricity. There are several varieties of each nature, as turned out by different manufacturers. The ideal motive power is electricity, which requires only light machinery. But electric current is only available in cities, and never in the field; while our present accumulators are so imperfect that 60 miles is the maximum distance which a motor wagon will run on one charge. There is therefore no likelihood of electric wagons being used in the field for some years to come.

At present petrol may be considered the best motive power for military purposes. The petrol motor is an explosion engine in which charges of petrol vapour mixed with air are exploded in the cylinders. The engine works on the Otto cycle, and runs about 400 revolutions per minute. Experiments are being conducted by several Powers with paraffin, alcohol, and steam; but in general the petrol motor is preferred, as giving the best results. It is lighter, more powerful, and more reliable than any of its competitors.

All motor wagons are much the same in build, and are characterized by a platform for the load and small wheels. The tare weight of a motor wagon is about 1·6 tons. Its speed is 6 to 7 miles an hour; this is because the machinery requires to be thoroughly cleaned after every 8 hours' running.

In the Austrian army we are trying the Daimler motor wagons, built specially for military purposes. These are manufactured in Vienna. They have four-cylinder petrol engines of 10 H.P. (nominal). Ignition is either by tube or by electricity. The average road-speed is over 7 miles an hour.

These wagons were at first built to carry a load of 5 tons. But the total weight was too great, and the present wagons are constructed to weigh 1·8 tons and to carry 2 tons. Besides this load the wagon will pull two trucks each loaded with 2 tons. These trailers can be uncoupled

expenditure for that campaign on hiring transport animals and carts, and indemnities for broken-down wagons and disabled horses, amounted to over a quarter of a million sterling.

Not the least of the advantages of motor transport is that it does not injure the roads, whereas horses' hoofs cut up the surface badly.

But the greatest military advantage of the motor wagon is that it shortens the transport column. Thus, one supply echelon of an infantry division consists of 72 country carts, carrying a net load of 32 tons and occupying 833 yards, or nearly half a mile, of road. It has 144 horses and 72 drivers, who have all to be billeted and fed. Set against this a modern Daimler road train, consisting of one tractor carrying 2 tons and drawing two trucks, each of which also carries 2 tons. One supply echelon would require four tractors with two trucks and two with one truck, total six tractors and ten trucks, taking up only 165 yards of road-space. The personnel would be reduced to 12 drivers. The road-speed of the supply echelon would be 6·2 miles an hour, except when marching with other troops, when it would have to conform to their pace.

The organization of the lines of communication, which is always a difficult matter, will be much facilitated by the increased speed of the motor wagon. Thus, one stage of the lines of communication of an Army Corps requires 3,000 country carts, 3,000 drivers, and 6,000 horses. These can be replaced by 60 tractors drawing 120 wagons, with 120 to 150 drivers and assistants.

The immense saving in expense effected by this reduction of the numbers of men and horses will be evident on considering the figures for the Bosnia-Herzegovina campaign. Although market conditions were favourable, since only a portion of the Army was mobilized, the cost of a ration in that campaign was 1s. 3d. and of a forage ration 2s. 0d. This includes cost of freight and transport. In the present case the saving would, at these rates, be over £1,000 a day.

If the *whole* army were mobilized, prices would be far higher than the above rates.

If we consider the reduction of personnel for a whole army, rendered possible by the substitution of motor for horse transport, we shall find that the saving on rations and forage alone would cover the cost and upkeep of the necessary road trains.

Moreover in the interests of agriculture it is economically sound to avoid taking large numbers of horses from the country to complete our transport for war.

Mechanical transport may be classified as:—

1. Traction Engines.
2. Motor Wagons.
3. Motor Cars.

TRACTION ENGINES.

These have been recently improved by the adoption of the compound engine, increase of boiler pressure, spring suspension, and in some cases spring-centred wheels. The driving wheels are broad and high, and the

TRANSCRIPT.

THE AUTOMOBILE IN WAR.*

From an article by "RAISZNER" *in the* WIEN MILITÄR-ZEITUNG *of 5th and 13th February*, 1906.

AUTOMOBILE carriages have now reached such a stage of development, both from an engineering and a military point of view, that their general introduction into the Service cannot be much longer delayed. To an army in the field they will be of the greatest value.

In the great armies of the world a keen interest is felt in the development of the motor carriage, and in its perfection as a military machine. After years of experiment, their ideal has been attained, or nearly so. Not only has the machine been improved, but experience has led to a better understanding of it. The number of automobiles in use as pleasure carriages and for passenger and goods traffic is increasing every day.

The motor carriage has two great advantages over horse transport, namely speed and cheapness. The cost of its upkeep, including interest on prime cost, is relatively low. These two advantages will enable the motor to displace all other forms of road transport. And the manufacture of motor carriages on a large scale will lead to their being produced much more cheaply than at present, so that many persons now unable to keep a carriage of their own will be able to have a motor.

The general introduction of motor cars will revolutionize the conditions of military transport.

We learn from history that the transport of the supplies of an army has always been a most difficult matter, and that transport has often broken down at critical times with disastrous results. Even in the Franco-German War, where the organization of the transport columns was exceptionally perfect and the roads remarkably good, horse-drawn transport frequently broke down.

The latest war in which we Austrians have been engaged—namely, the occupation of Bosnia and Herzegovina—enabled us to realize to the full the difficulties of road transport. The roads were abominable, the weather bad throughout the campaign, and the country was flooded in many places. It was only by very heavy labour on the part of the troops, who had to build new roads and repair old ones, that these difficulties were overcome. But this meant a great waste of time and money. The

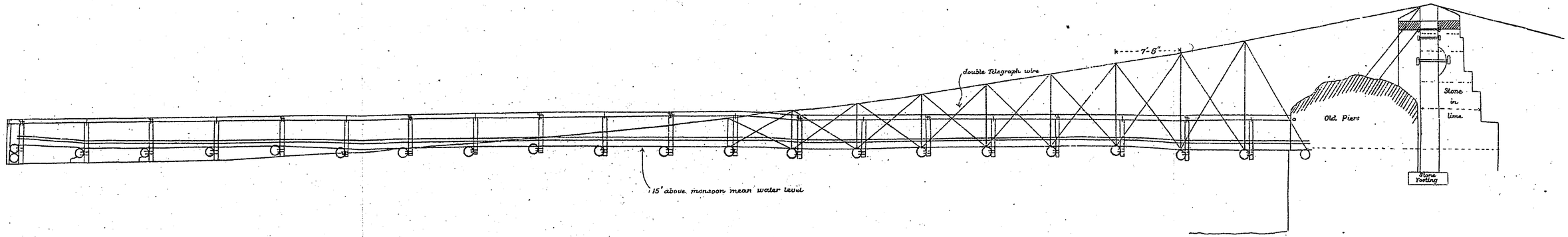
* *Communicated by the Chief of the General Staff.*

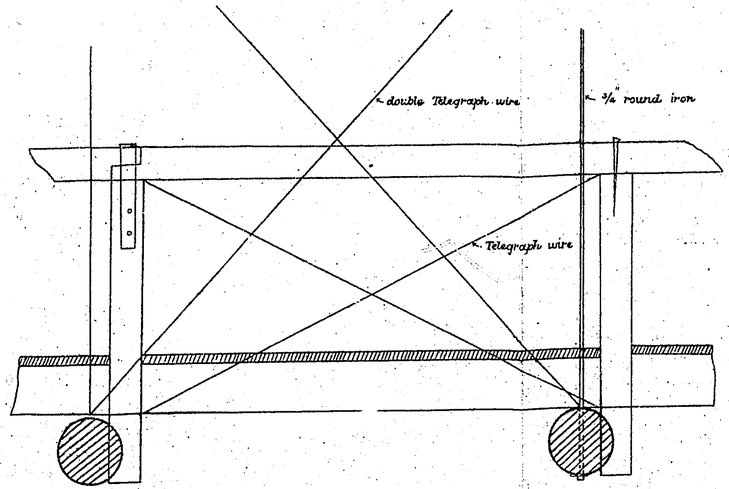
BHUNTAR TEMPORARY BRIDGE

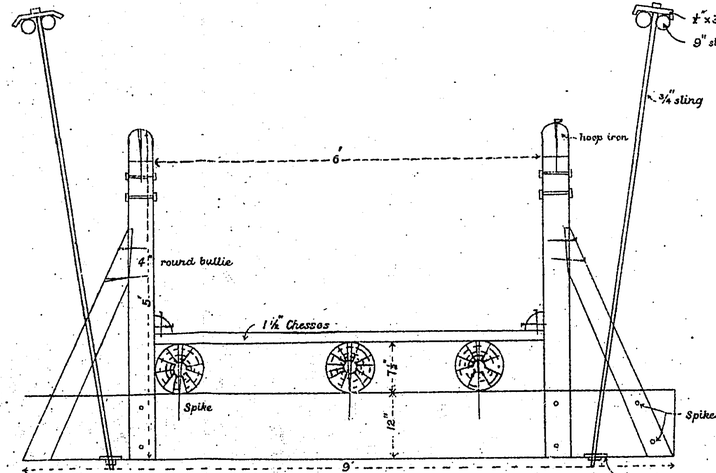
Plate I.

Span 326 feet

Scale 10' = Inch.

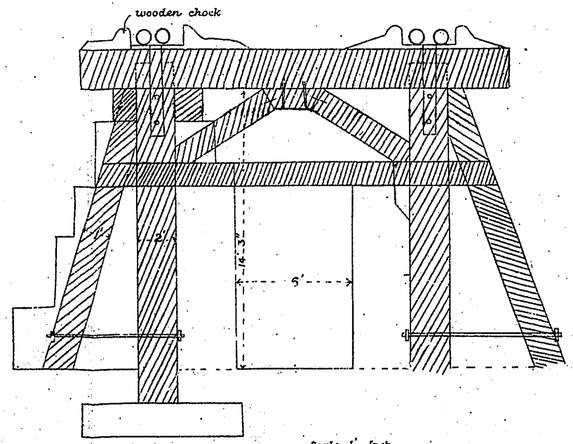






Scale 2' = Inch

Inches. Feet.



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,, C. C. Newnham....Indian Army.

*Read partly at the Army College, Aldershot.

August, 1904.

SEVENTEEN passed on the Competitive List and THREE received Nominations.

August, 1903.

TWELVE passed in the Competitive List and FIVE received Nominations.

August, 1902.

ELEVEN passed in the Competitive List and FIVE received Nominations.

PROMOTION.

More than EIGHTY OFFICERS who Read with us PASSED (*d*) in May last.

WOOLWICH, DECEMBER, 1905.

THE FOLLOWING PASSED DIRECT FROM US:—

SECOND	H. G. MacGEORGE		7,196
FOURTH	G. WALTON		7,046
FIFTH	H. A. COX		6,967
16th	R. CROFTON		6,330
45th	D. STEPHENSON		5,899
54th	J. KENNEDY		5,711

SANDHURST, DECEMBER, 1905.

THE FOLLOWING PASSED DIRECT FROM US:—

SEVENTH	L. H. CRIPPS		5,144
46th	M. E. C. JOSEPH		4,336
58th	A. G. D. O'FLYNN		4,215
59th	P. J. R. WIGLEY		4,212
61st	G. C. I. HERVEY		4,187

ARMY QUALIFYING (SEPTEMBER), FOUR.

PROMOTION.

More than EIGHTY Officers who read with us PASSED (*d*) in MAY LAST.

Work for both "C" and "D" is now going on.

Militia Military Competitive, March and September, 1905.

FOURTEEN PASSED.