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ENGINEER SCOUTING AND RECONNAISSANCE.

By MAJOR F. E. G. SKEY, R.E.

THE complaint is often heard that little use can be made of the services of Engineers in peace operations. While studying how this defect may be remedied, it is suggested that a great deal may be done by the increased development of Engineer scouting and reconnaissance; for although it is true that only a small proportion of the men can be actually employed on such duties, yet the reports obtained would in all probability reveal useful work for the remainder, which can either be actually completed, or at any rate carried to the point of the distribution of the working parties.

The suggestions made in the following article deal with the subject from the point of view of peace training only, although at the same time it is recognized that on service, in future campaigns, Engineers will be expected to possess a very high standard of reconnoitring skill, on every subject which affects their own line as artificers and fortification experts, and that this can only be obtained by paying special attention to such details in peace time.

The first essential point to be realized, is that all officers and N.C.O.'s of the field companies should be thoroughly trained in all kinds of Engineer reconnaissance duties, and should be able to report clearly and concisely, either by a rough sketch or in writing, on any details and information which they may have acquired.

In addition to this, a small proportion of N.C.O.'s and men should be specially trained as scouts. They should be young and active men, equally at home on bicycle and horseback, and after a period of training they should be subject to special inspections, and competitions and prizes should be offered to test their efficiency.

So much for the men. We will now turn to a consideration of their work on the march, in camp, in defence and in the attack.

On the march the Engineer scouts should be pushed as far to the front as possible, to obtain the earliest information of any obstruction to the march of the advancing columns. If the line of march passes through any important defile, bridge, or mountain pass, it would be useful to send forward special men to report. If it is a bridge, a full description of it should be prepared with a scheme for its demolition, and information as to the resources of the neighbourhood for its repair if it should have been demolished. If a mountain pass, whether it is blocked and requires clearing, or how it can be blocked or mined, and what important parts of the line can be demolished in case of a retirement.

The resources of towns and villages passed through, in bridging or hutting materials and smithies, etc., should be noted, and stores of stone, brick, or road metal along the road or in neighbouring kilns or quarries should be reported upon. Information on such points should be accumulated in the hands of the C.R.E., and some of it could not fail to be subsequently useful.

The reconnaissance of a line of river or mountain range would probably be carried out rather from a halt than on the line of march. Here, for the purposes of the reconnaissance, the line should be divided into sections among several officers or N.C.O.'s.

For a river, information would be required as to existing fords and bridges, boats, stores of bridging materials, sites suitable for bridges, with special reference to the approaches on both banks, and details as to sections, and the condition of bottom and banks.

If the line of the river is held by the enemy, the gathering of this information may require a considerable amount of skill and ingenuity, and men possessing a natural aptitude for this kind of work can only be found by practice.

The information required about a mountain range would include descriptions of the various roads and bridle-paths, their gradient, state of repair, and suitability to the various kinds of transport. The materials at hand for their repair and their capacity for obstruction, whether by means of obstacles, demolition, or defensive works, may also be noted.

Turning now to the reconnaissance of camps, the Engineer points of research are the approaches, the water supply, and the approaches to the latter. As regards approaches, existing entrances may require widening, or fresh gaps may have to be cut, and in this connection it would be useful to find where brushwood can be cut for making fascines and mats for the bad places which often grow in the entrances to camping grounds. The watering places for drinking, horse watering, and washing must be decided upon, and the requirements in pumps, troughs, and other arrangements settled. Here everything has to be done in a hurry, in order that there may be no block on the road or delay in watering the horses when they get in; but the Engineers need not rest content until all possible sources of water supply and all possible approaches which may relieve congestion in the watering, feeding, or moving of the troops have been examined and reported on.

If other possible camping grounds are known of within the area occupied by our troops, reconnaissance parties should be sent to report on them, in order to increase the store of information in the hands of the C.R.E.

The camp may depend for its supplies upon a railway, and in this case the stations should be reported on as to platform accommodation and materials available for making additional platforms and sidings. If the supplies are conveyed by river or canal, the wharves and landing stages should be reported on, and the resources available for erecting others, or for increasing the accommodation of existing ones. The reporting on a line for a possible tramway to be made between a railway station or wharf and a supply depôt, would come within the scope of Engineer reconnaissance.

In the *defence* Engineer reconnaissance falls under the two general headings of (i.) the selection of the position and (ii.) the execution of the works. It is possible that the Engineers may not be consulted in the selection of the position or in the siting of the various works, but none the less it is their business to be specialists on these subjects, and the better specialists they are, the more likely are they to be consulted. For this reason the selection of defensive lines and the siting of trenches, etc., is a branch of our training which should be exercised on every possible occasion.

But while (i.) is going on, there is a great deal to be done under the heading of (ii.), in preparation for the execution of the works. A careful reconnaissance of the neighbourhood should be carried out, to bring to light all stores which can be utilized in the defence, and to find how they can be conveyed to the position. Sawn timber of various scantlings, suitable for revetments and head cover, corrugated iron, sacks, timber growing or cut, suitable for stakes, and wire, both plain and barbed ; tools ; labour and carts ; brushwood for revetments and fascines—these last with brick or stone may be required in approaches, or in gun emplacements ; gravel for use in the head-cover sandbags ; water receptacles ; paint. These should be reported on and arranged for each section of the defence separately, and in each section a site for the Engineer park must be selected where materials can be brought up and distributed, and where tools can be repaired, stakes cut and sharpened, and other rough work carried out.

The Sappers in the defence would probably be extensively distributed, and it is hardly probable that they would be charged with the construction of any of the entrenchments, even in the most important parts of the position ; but the obstacles, including land mines, flares, and alarm guns, would probably be entrusted to them, and they might help in the construction of covered communications, blindages, and head cover, while the approaches to and floors of gun emplacements, especially for the Long Toms, might also require their assistance.

But it is in the *attack* that the most important reconnaissance work will be required of the Engineers, and probably no attack will be carried out in future until the most minute technical details have been ascertained. It is here, more than anywhere, that the Engineer must decide how he can help forward the success of the operation.

In the first place he will look for natural obstacles, streams, bogs, etc., which the attack will encounter in its advance, and how and where they are to be crossed, what roads will carry infantry and what artillery, and where preparations must be made for the passage of the various arms.

Next there are the artificial obstacles, what they are and where placed. All details must be very exact, and localities must be selected for pushing in clearing parties to demolish them. Incidentally the other defence works may be noted, but the obstacles, and how to get the troops through them, is essentially the problem of the Engineer. It is not easy to get training at this work, and no opportunity should be lost when troops are entrenching to exercise Engineers, officers and N.C.O.'s, in advancing under service conditions and making large-scale sketches of the works, as far as they can ascertain them, in the short sections within their immediate purview.

Another subject for reconnaissance in the attack is the selection of *points d'appui* or pivots, which may have to be seized and entrenched in order to secure a foothold within the enemy's position. It is possible that the selection may have been already decided, but even this important decision may sometimes await the result of the Engineer reconnaissance. The work of fortifying these points, when once taken, would probably be entrusted to the Sappers, who would therefore, with the exception of the parties detailed to clear obstacles, be massed in the attack, though disseminated in the defence. The reconnaissance would have to decide how the men and tools can be pushed forward; what tools are likely to be required, what proportion of picks, shovels, jumping-bars, and felling-axes; whether wire and stakes are available on the spot or must be brought up; how far the tool carts and store wagons can be brought, and by what line. Some idea must be formed of the perimeter to be occupied and what class of works is to be attempted. The capture will probably take place early in the night, and the more complete the arrangements made beforehand, the greater the amount of work which will have been done before the arrival of the inevitable counter-attack.

There is therefore a great deal that can be done on manœuvres in the way of reconnaissance and scouting, and it is probable that, as a result, all ranks of the field companies would find abundant employment; in fact it might even be considered advisable to make up the companies for manœuvres to nearer their war strength, by drafts from the Territorials or by some other means.

In this article suggestions for the outlines of this important branch of our training have been roughly sketched, but much more might be written about the special reconnaissance duties, not only of the field companies, but also of the telegraphs, railways, and other technical branches of the Corps.

STUDIES ON THE USE OF FIELD TELEGRAPHS IN SOUTH AFRICA.

By MAJOR E. G. GODFREY-FAUSSETT, R.E.

V.—SEMI-PERMANENT TELEGRAPHS IN GUERILLA WARFARE (THE BLOCKHOUSE SYSTEM IN THE TRANSVAAL).

DURING the last year of the war the telegraph organization had a semi-permanent aspect. The disturbed area was divided into four divisions—Cape Colony, Natal, Orange River Colony, and Transvaal—each under a local Director. Two Clearing Houses were established, one at Bloemfontein and one at Pretoria; Cape Colony being attached to Orange River Colony, and Natal to the Transvaal for this purpose.

The following is a description of the organization established in the Transvaal, and modelled as far as possible on the organization of the Post Office in England.

The Administration occupied in Pretoria a bungalow which had been taken over from the Boer Telegraphs. There were four departments:—

(*a*). Engineers.
(*b*). Surveyor.
(*c*). Accountant.
(*d*). Stores and shops.

The Engineering branch was controlled by the Director, with one or two subalterns as assistants. Every new work was estimated for on a printed form by the Inspector concerned, and was allotted a numbered Works Order, to which all stores or cash payments were charged. The Works Orders were lettered according to the nature of the service—telegraphs or telephones; military, civil administration, or private (paid)—and were numbered consecutively in each class.

The Surveyor's branch, under a civilian, was responsible for (1) the control of the traffic generally; (2), the issue of the necessary circulars and instructions as to the complicated and constantly varying rates for telegrams to and from cable companies and other administrations; (3), for the collection and handing over to the Clearing House of office copies of telegrams; (4), the control of the very numerous civilian staff.

The Accountant's branch dealt with all money matters except the pay of soldiers, which was kept on an ordinary pay list. Five thousand pounds a month were drawn on imprest from the Army

Pay Department, and the receipts for private telegrams and rent of private telephone lines were very considerable—telegrams amounted to £41,592 and telephones to £30,236 during the whole period.

The Storekeeper had charge of all spare stores, whether found in the country, received from Ordnance, or purchased, and issued them as required, on Works Orders. Smiths', carpenters', collarmakers', and telegraph mechanics' shops were situated in the stores yard, where was also a kraal for spare ponies and mules.

The next link in the chain of organization, and the most important one of all, was formed by the Inspectors. The Transvaal was divided into 10 sections, each under a senior N.C.O. as Inspector. The Inspectors were responsible for all details of the telegraph service:—the regulation of the traffic; the control of the staff, both operating and engineering; the repair and maintenance of lines and instruments; the collection of office copies of messages, and of cash accounts; estimating for and carrying out new lines; the payment of all soldiers and civilians, except civilian operators who were paid by cheque direct from headquarters; and the military discipline of all soldiers employed on telegraphs in their sections.

This was a great responsibility, and right well did the N.C.O.'s rise to the occasion. As examples I give the actual figures of 1st June, 1903, for the Johannesburg and Middelburg sections, selected as examples of town and country:—

	Johannesburg.	Middelburg.
Instruments working:—		
Wheatstone automatic	3	1
Quadruplex	2	—
Duplex	6	1
Simplex	27	24
Vibrators	4	2
Military telephones	84	244
Town telephones	774	—
Staff:—		
Operators—R.E.	38	30
Infantry	4	13
Civilian	50*	9
Telephone operators (civilian)...	23*	—
Messengers (civilian)	43*	6
Linemen—R.E., Sappers ...	8	19
Drivers ...	—	2
Civilian	9	—
Working parties—R.E. ...	19	4
Civilian ...	18	—
Natives ...	144	27

* The civilian staff at Johannesburg was to a certain extent controlled direct from headquarters.

Transport :—

	Johannesburg.	Middelburg.
Native drivers	16	10
Mules	73	28
Horses	12	17

Below Inspectors, the organization divided into linemen, telegraph masters, and foremen of working parties. The linemen were each responsible for the lines in a definite section of country, the telegraph masters each for their own office and the staff of operators, and the foremen for their working parties.

As the Boers had lost all their guns, the era of blockhouse lines, in the spaces between which "drives" could be carried out by mobile columns, had set in. Five lines of railway radiate from Pretoria and Johannesburg, to the N. to Pietersburg, to the E. to Komatipoort, to the S.E. to Volksrust, to the S. to Vereeniging, and to the W. to Klerksdorp. These first were protected throughout by blockhouses, eventually at distances of about ½ mile apart, and afterwards other cross lines were run between them, and to join up with lines in the O.R.C.

The stations on the railway lines, and the defensible posts at 15 or 20-mile intervals on the veldt lines, were supplied with telegraph offices working in to some local centre. From these telegraph offices telephone lines extended in each direction, telephones being fixed in every third or fourth blockhouse—in some cases more frequently. The telephones were worked by the troops defending the blockhouse line, but maintained by the telegraph linemen. In addition to these, each town or post of any importance had a local exchange, and telephones to all the forts, posts, camps, and offices.

On the railway lines the existing poles were utilized, additional copper wires being run with permanent brackets and insulators by working parties as required. Thus three wires throughout—in many places four—were added from Pretoria to Komatipoort, a distance of nearly 300 miles.

On the veldt the practice was to run the lines simultaneously with the erection of the blockhouses, a section under an officer erecting the line, which was handed over for maintenance to the Inspector concerned when it was finished. Nearly all these veldt blockhouse lines required two wires throughout, so that the field air-line equipment was not altogether suitable. All the Mannesmann poles (poles iron, semi-permanent, Mark II.) which could be obtained were quickly used up; a great quantity of poles, wood, 15-foot (a wooden pole in two pieces), was got out from England and used; and many light 15-foot poles manufactured in South Africa were erected. The insulators were of any small pattern that could be obtained—the field insulator did well, but any small cup was suitable; and the wire was mostly 100 lbs. to the mile, single strand copper, purchased locally.

The supply of telephones was a great difficulty, some 1,100 field instruments being used in the Transvaal alone. The greater portion of these were what is now known as telephone sets, portable, C, Mark I., and were purchased from Messrs. Ericsson through their local agents.

Several entirely new permanent lines were run, notably 30 miles of iron poles carrying eight revolving copper wires for telephone trunk purposes, between Pretoria and Johannesburg.

As the supply of Sappers was insufficient, considerable use was made of civilian operators and linemen, especially in the towns. The later drafts of linemen consisted chiefly of hastily trained men recruited from the National Telephone Company. These men did good work, but required a considerable amount of training before they got into Army ways.

The distances were so great that practically all the country linemen had to be mounted. Fortunately the ponies in use did not require skilled horsemanship; all linemen in the field telegraph companies are now taught riding and the care of horses.

The following statistics from the official History of the Telegraph Operations will be of interest; they cover the entire period of the war:—

Total *personnel* employed	2,753
Number of telegraph offices opened	1,050
Cable, miles run	3,749
Air line, miles run	2,191
Number of words dealt with	13,500,000

The total cost, debiting pay, purchase of stores, etc., and crediting cash received from the public, value of stores handed over to P.M.G.'s, and value of messages sent for Colonial Governments, worked out at £324,000. If the cost of the telephone connections made for the Army is deducted from this at the local rates, the cost per word of telegrams sent for the Army appears at $\frac{1}{3}$ of a penny.

COAST DEFENCE AND HOME DEFENCE.

By Bt.-Col. F. R. Reynolds, late R.E.

Within the last year several articles have appeared in this journal on the subjects of Home Defence and Coast Defence, but as the subject is one of such supreme importance to us Islanders, I will risk another article on the same subject being deemed superfluous, in the endeavour to present something which may assist towards the solution of the problem.

The importance of the subject and the pressing need for taking action, seem to me to be insufficiently expressed by the authors of the various articles, and only to have been treated from an academic point of view. Colonel Hickson's scheme surely is a counsel of perfection. Whether he advocates permanent works or not, his scheme would result in a chain of such works, whose intervals are to bristle with more or less mobile artillery, and the cost would be millions. The principle may be sound enough, but if it were proposed to spend these millions in defence works, the voice of the nation would probably say "No, we would rather have a stronger Navy."

Is there then any real necessity to do anything except keep up our naval superiority? Why is any other measure of general coast defence required? These are questions which puzzle "the man in the street," and the answers he gets from politicians and from experts are most contradictory. At one moment he is assured that not even a dinghy's crew could land on our shores, at another, that, as a bolt from the blue, some 100,000 men will gain their foothold, armed, equipped, and thoroughly organized, in spite of all that our Navy can do. However much or little we may believe in either of these extreme views, common sense and reason both warn us that we cannot expect in time of war to be free from attempts on the part of the enemy to damage our prestige and our property by raids.

In order to reckon how we now stand as regards raids, let us imagine that a state of tension exists between ourselves and another Power. Our Government does not take the steps necessary to prevent our antagonists securing an initial advantage, lest such steps should precipitate the conflict which "they still hope to avoid." The other Power means war all the time, and in the grey of the dawn one day, some of our undefended coast towns find themselves in the hands of the enemy. There may be no more than 100 men in one place, perhaps not more than 500 in any. Their mission is to do the greatest possible damage in the smallest possible time. From a military point of view the permanent result of this action might be *nil*, but it is impossible to realize fully the extent of damage to the nation's prestige, and the extent of confusion and loss in business circles these little raids might effect, as well as the amount of initial advantage they might thus confer on our adversary.

As regards their local effect also, would or could the inhabitants offer any resistance, or even know in what way they might minimize the result of the raid? No! All they would do would be to spread the alarming news, and exaggerate it; to inoculate their immediate neighbours and the whole country with their own panic, probably hindering any troops who might come to their assistance. The inhabitants of these places, though far outnumbering their raiders, would be useless at such a crisis.

Some scheme of coast defence therefore, as well as of home defence, would seem to be necessary, so that this danger may be obviated.

Self-preservation being the first instinct of human nature, and the British character having this prominent feature, that it prefers both work and play with something of sport in it, we have to first persuade the men we want that, for their own preservation and for that of their wives, families, and property, an efficient home defence force is a vital and pressing necessity, and we have then to devise a scheme for making the training of that force such as to appeal strongly to the sporting side of the British character.

At this point it will be useful to re-state some of the points *as to defence against raids*, which have been brought forward in previous articles, and as to which there is not likely to be disagreement.

Capt. Slade, R.N., in a lecture on "Strategy in Relation to Coast Defence," said:—

(*a*). Disembarkation should never be allowed to take place unopposed.

(*b*). A small number of men properly placed, are sufficient to make a raid a work of very great difficulty and danger.

(*c*). The proper time to deal with such expeditions is when the enemy's men are crowded together in small boats approaching the shore.

(*d*). Sufficient fixed defences are required to delay raids until reinforcements can come up to deal with them.

(*e*). It will be too late to get the men to their stations if we wait until the ships are sighted. Within an hour of that time it would be quite possible for a covering force to land.

Colonel Hickson says in addition :—

(*f*). A land attack on a defended port should be made impossible.

(*g*). The enemy must not be permitted to land.

(*h*). Whatever our system of defence, it is neither guns nor ships nor machines of any sort which in the end decide the fate of nations ; it is the training of the men.

Capt. Slade in his lecture referred to large shipping centres, manufacturing or shipbuilding towns on the coast, wireless telegraph stations, and naval bases as liable or more particularly liable to raids ; but, as I have mentioned above, a raid might be attempted on other parts of the coast, not so much with the object of doing serious military damage, as of influencing the political situation through the agency of the nerves of "the man in the street." It would seem somewhat unwise therefore to confine our defensive preparations wholly to such places as obviously invite raids, if our resources allow us to make our coasts generally uninviting.

Fortunately our coasts are on the whole populous, and the more populous where the objective is more attractive ; so that anywhere and everywhere they might be required, there is to hand the "small number of men" mentioned in (*b*) above. All that remains to be done is to induce these men to be trained, to see that they are properly and sufficiently trained, and to ensure that when the time comes they are "properly placed."

Capt. Slade's dictum, that it will be too late to place the men in position if we wait until the ships are sighted, is extremely important, as a considerable time would be occupied in the processes of conveying the intelligence from the look-outs to the O.C. troops in the neighbourhood, issuing the necessary orders, assembling the men, marching with due military precautions to the threatened point, and taking up positions to resist the landing. We need not perhaps take Capt. Slade too literally. To have all the troops, which we allotted to the defence of our shores, in time of emergency lying in wait always for the enemy's attack, would be preposterous, but it should not be impossible to strike a happy mean between being always unready and always too completely ready.

"A small number of men properly placed" would appear to be the clue to the solution of the problem. In Colonel Hickson's view the proper place is behind artillery, in many cases behind artillery of such calibre as to necessitate fixed and practically permanent works. He says, "*200 artillerymen behind guns well placed on the coast on the flank of a defended harbour, are equivalent to something like an inland garrison of from 1,000 to 2,000 men manning guns on its land fronts.*" This may be agreed to for the special purpose he is considering, but it should not be accepted too hastily as being right for general application. The curse of fixed defence works is that they render so many men immobile, and coast defence works render immobile not only those manning the guns, but about an equal number of infantrymen to secure the guns themselves from surprise attacks. There these men are, and, being allotted to these somewhat costly works, there they will remain, however urgently they may be required at some other point on the coast. So it may be said without exaggeration that *for general purposes of coast defence 200 men free to move are worth 1,000 men tied to fixed defences.*

I do not wish to combat the view that guns and works are desirable on the coastal flanks of our defended ports, but I wish to insist that, as these works require infantry to protect them against raids, the natural inference is that infantry, rather than artillery, is the arm on which we must depend, in the main, for general coast defence.

Having got thus far, it will be desirable now to consider what sort of training is required for our coast defence infantry.

A fully-trained soldier must have a knowledge of a wide range of subjects, but the end of all his training is evidently to make him fitter than his possible opponent, to plant bullets in the desired spot at the desired time. The reason that the soldier requires so wide a training is so that he may fulfil his mission anywhere all over the world, under circumstances perhaps of great difficulty and danger, which would soon render a poorly-trained man *hors de combat.*

The men whose training we are considering however are more fortunately circumstanced, more fortunately both for themselves and for their country. All that would be required of these men is that, when the time comes, they should line their native and familiar shore, and plant bullets into the approaching enemy. They would live most of the time in their own homes, be tended when sick or wounded by their own people, should have at their fingers' ends a knowledge of the defensive capabilities of their coast, and of all the natural or artificial aids to picking up ranges, and they would know that, if attacked, they had only to hold on for reinforcements to come to their assistance from all sides. It is evident that in this case the advantage of the defence over the attack is so great, that the fully-trained soldier of the attack (and that he would be not only fully trained but picked there is no doubt) could be resisted successfully by a much less fully-trained defender.

In an army all hands require general training as soldiers, but in addition they require special training for the particular branch of the army to which they may belong. Where men can devote only a small part of their time to military work, it is a question whether much more than the special training can be attempted. The case of the Volunteer Submarine Miners was one in point. These were men selected for their knowledge of electrical work or boatwork, and trained for little else than their special duties as submarine miners.

The result was most successful, but had these men been required to undergo a lot of general military training, as well as their special training, they would have fallen between two stools.

It seems to me therefore that when one speaks of the "less fully-trained defender," it does not follow that it means he need be less trained in regard to some particular branch of military knowledge. Our object should be, in fact, to give him as good, or better training, than his possible opponent is likely to possess, in the particular branch which is most likely to be useful—in this case evidently in musketry.

The unfortunate enemy, once he has quitted his transports to make the attempt in small boats to reach the shore, can make use of none of his training, and during this transition period any men on shore with rifles would have an advantage over him. One of our axioms however is that the enemy must not be allowed to land. To prevent a determined enemy from landing, will necessitate not merely that he should be made very uncomfortable in his approach to the shore, but that he should be absolutely demoralized by his losses. If we would make sure of achieving this result, our men on shore must be experts at firing at marks floating on the sea, and not only should their fire be deadly at medium ranges, but it should begin to be terribly effective at the maximum range of their rifles.

Now firing at a mark floating on the sea differs from firing at one placed on land, because the sea forms a more or less luminous background, against which the floating object appears with much greater distinctness than would an object at the same distance on land. The result of this distinctness is that ranges over sea are very much under-estimated by those unaccustomed to judging them. Another result of course is that the object is more easy to aim at than if at the same range on land, the absence of any obstacles to direct vision, except possibly waves to some extent, contributing to the ease of aiming. A dinghy seen at the extreme range of the rifle is a prominent object, and the much larger boats used for the attempted landing would provide very satisfactory marks for our expert coast defenders, from the moment they came within range. Wave motion, on the other hand, is against accurate marksmanship to those who have not studied it. All this points to the conclusion that our coast defenders must be trained not on land ranges but on sea ranges.

Seeing how increasingly difficult the provision of land ranges is becoming, the fact that for the purpose under consideration sea ranges are best, is a fortunate one for us. Possibly many will doubt whether ranges over sea with floating targets can be devised in a form suitable to give the required training, but there would appear to be no inherent difficulty in devising means whereby the result of a man's shot at a floating target should be made known to him, and this is all that is essential for a commencement. A target which apparently signals electrically each hit made as well as its position, has just been invented and is about to be manufactured. Space for ranges is practically unlimited, although at popular seaside resorts it might be necessary to suspend practice at certain seasons. Boats, which had completed their useful life in the Navy, instead of being sold as scrap iron might be patched up and used as target platforms. Some of these boats could have their engines left in, and could tow other boats containing dummies to represent a raid, moving round the coast so as to afford tactical exercises periodically to the different sections. Nor is it intended that these men should have no training beyond musketry; some drill is naturally necessary, as a sense of discipline must be imbued.

The main thing to be borne in mind would be that the training of these men, instead of being directed towards fitting them for universal service, would be concerned only with the single and definite purpose of making them coast defenders. Such a course has several advantages; first of all it enables the men who are willing to devote some of their leisure to the purpose, to make themselves really effective for the defence of their country. It cannot be gainsaid that the volunteer has proved his ability to become an expert shot, if he is given opportunity of sufficient practice. Also there is no reason to suppose that the fascination of rifle shooting would be less over a sea range than on a land range; in fact, it seems probable that the greater realism, which possibly might be evolved on sea ranges, would add a zest to the pastime.

It is evident that in case of our being involved in war with a power of any naval pretensions, we should either acquire gradually or lose gradually the command of the sea. We could not hope to gain it immediately, though we should hope not to be too long about it; we certainly should expect that it would be a very long time before we lost it. This period of naval activity would also be the period of raids, which, as mentioned above, are liable to give rise to nervous clamours very unwelcome at such a time. Can anything be imagined as more likely to be effectual in nipping raids in the bud, than the knowledge that behind our fleet was a body of troops specially trained to deal with them, deadly accurate as shots, and ready as well as eager to meet the enemy at any point he liked to select?

Given such an outpost line as this, the six months training of the rest of the Territorial Army could proceed without fear of disturbance. The scheme for this outpost line being based on the instinct of self-preservation, should appeal powerfully to our coast-dwellers if it were put before them properly; consequently one would expect it to be successful as regards obtaining the numbers required. The training need involve but little military formality, a thing abhorrent to many civilians. The rifle practice would prove more interesting than that on land ranges, owing partly to the ever-changing conditions of light and movement in the sea, and partly to facility for movement on the sea, rendering changes in tactical conditions easy to devise. For these reasons one would expect the force to become efficient with only the training which could be given in the spare time of its members, although it would be desirable that these outpost troops should participate as far as possible in the six months general training of the Territorial Army.

I have dealt now with all the points referred to in (*a*) to (*h*) above, except (*d*), to which I will refer presently. Here I will recapitulate briefly, to show that the scheme, besides being based on strong human instinct, and being suitable to British character, is also logical.

The Territorial Army must have six months training after mobilization to make it fit to take the field; to ensure the possibility of giving this training our coasts must be strongly defended. Such strong defence is only possible by having troops on the spot and specially trained for it. This special training will be very popular, and can be given in the leisure hours of the men who are available, and who live on the coast.

At (*d*) above, fixed defences are mentioned. As to these one cannot say much, except that they must be thought out for each locality, be suitable for the number of men available, and that they should be of as simple and easily constructed a character as possible. Fixed defences in the shape of batteries for artillery of heavy calibre, I would deprecate as a general rule, but I would not wish it to be understood that I do not appreciate the benefits which artillery is likely to confer on the defence. I believe that there would be plenty of men available for all arms, but I would like first to make sure of having plenty of infantry, and from that basis to evolve the whole force required. As far as possible (and a good deal is possible in these days of motor traction and our good roads) the artillery should be mobile.

Finally, to deal with some of the objections which will be brought against this scheme.

First it will probably be said that I am making the fatal military mistake of trying to be strong everywhere. There is a vast difference between *being* strong and *trying to be* strong. All I am proposing to do is to take advantage of the strength which exists everywhere along our coasts, but so far has not been sufficiently utilized.

Again it may be urged that the proper way to make use of this strength, is to collect the men available into strong bodies which can be brought to bear decisively against the enemy, as soon as it is known at what point his attack is to be developed. It seems to me however that it would be folly, when we can keep the men in their own homes, to collect them in camps at some distance from the shore. This would give the enemy, who has the initiative, the choice of route and the superiority of speed, the opportunity he requires, as he could cause the collected body of troops to move in the wrong direction by means of a feint. If on the contrary our coast outposts remain in their own homes, they will be strong enough everywhere to delay the enemy's landing, there will be no chance of mistaking a feint for a real attack, and against the real attack an ever-increasing number of defenders will rapidly arrive by motor, cycle or train.

To deal with one more objection; it may be urged that if this force is only an outpost force, why have it so strong. Outposts on a land front are kept as weak as possible, owing to the hardship and fatigue of the work which exhausts the troops employed on the duty; but in case of real necessity there is no hesitation in increasing their strength. Again, in the case of land-front outposts the enemy's speed of advance is slow, and his route is usually confined to certain tracks; consequently the cavalry and infantry patrols in front of the line of observation should generally discover his advance in time to alarm the whole outpost force. Our coast outposts would face the sea, over which the raid-conveying ships would move with great rapidity and in any direction. They would have a good chance therefore of escaping the observation of our sea patrols (the fleet), and of appearing at any point they might select without being seen by any on shore but those within a few miles of the point attacked. Hence arises the necessity for the coast outposts to be stronger in proportion to the extent of front covered than ordinary outposts usually are. As the men would live in their own homes, the hardships and fatigues of the work would be reduced to a minimum, and altogether it would not appear that the objection to having a large force employed on outpost duty holds good in this special case.

The case of defending a coastal frontier differs in many important particulars from that of the defence of a land frontier, and in consequence requires special measures, which may seem to differ from accepted military principles. The scheme I have proposed above has, I hope, the merit of being logical and based on common sense; also of being effective not only against raids, but as far as any scheme of land defence can be effective, against invasion also.

BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.—DUBLIN, 1908.

EXTRACTS FROM THE ADDRESS TO THE GEOGRAPHICAL SECTION BY MAJOR E. H. HILLS, C.M.G., LATE R.E., PRESIDENT OF THE SECTION.

THE 30 years that have elapsed since the British Association last met in this city of Dublin have seen an obvious and rapid progress in the science of geography, and a steady though perhaps not quite so apparent a change in the character of that science.

In 1878 large parts of the earth's surface still remained untrodden by the feet of a white man; large areas were open to the enterprise and intrepidity of the explorer; large spaces were blank paper upon our maps. Now there is but little of the earth's surface absolutely unknown.

It is not my intention to detain you by any recapitulation of the work of these years to show you how and by whom these areas have been traversed and the gaps in our maps filled in. I intend rather to speak of the present and of the future work of the geographer, and to do this to any advantage we must at the outset recognize the change that has taken place in the nature of his task, and the fact that the days of individual exploration are over, never to return. We must recognize that sporadic, unorganized effort must be and is being replaced by organized work, and that the scientific traveller of the last century, with his rough map-making equipment, his compass, watch, and sextant, has yielded his place to the scientifically equipped survey party with their steel tapes, theodolites, and plane tables. * * *

I am not ambitious enough to attempt to cover the whole surface of the earth in the brief review that I intend to put before you of the progress of scientific survey. Rather I wish to restrict our outlook to that section of the work in which we may all be considered as having a direct personal interest—namely, the survey of the British Empire, especially those lands under the more immediate tutelage of the Government of this country. Let it not be thought however that while we for the moment pay little attention to the regions lying outside this definition, we are supporting the fallacious idea that the survey of any part of the earth can be considered apart from the survey of the surrounding country. With the possible exception of the case of an oceanic island, such an assumption would be an erroneous one. Our British Empire is so widespread and our possessions are so often in close and intricate juxtaposition with those of other nations, that there is in this work large scope, and indeed necessity, for international co-operation. * * *

Before proceeding to the consideration of our special subject, the survey of the British Empire, it will be interesting to interpose a few remarks on the questions of the utility and origin of national surveys in general. We may first note the somewhat curious fact that the production of a map of a country, useful as such a work is for many purposes, has almost always been embarked upon because the imperative necessity of maps of the theatre of operations in war has been brought home to the people and Government of a nation. Thus the ordnance survey of England had its first beginning in a military map of the highlands of Scotland, commenced in 1747, intended to facilitate the operations of the troops under the command of the Duke of Cumberland. * * *

In the case of our other great national survey, that of India, its origin is to be found in circumstances somewhat analogous. The Madras Government, owing to the success of the British arms in the Mysore Campaign, found itself with a great accession of totally unsurveyed country in the middle of the Peninsula, while at the same time there were only in existence the roughest sketch-maps of the older possessions. It was apparent that if any map, of even approximate accuracy, was to be made covering a country of such vast area, it was imperative that the work should be prosecuted upon the most rigorous and strictly scientific basis. The general lines upon which it should be undertaken were laid down in February, 1800, by Brigade-Major Lambton, who addressed a letter to the Madras Government advocating a mathematical and geographical survey of the peninsula. * * *

In this short recital of the determining causes which have in the past led to the initiation of national surveys it will have been noticed that no allusion has been made to what we should now perhaps consider the main utility of a map—namely, its value for all purposes connected with the ownership, development, and taxation of land. * * *

Neither were any of the early surveys undertaken for the purpose of mutual delimitation of international boundaries, a necessity which has in recent years been the stimulating cause for many pieces of valuable survey work, especially in Africa.

Let me now turn to the main subject of this address—the enquiry as to how far the duty of adequate mapping of our territories is performed by us, what shortcomings we can perceive, and what suggestions we can offer for the future.

Two years ago this task would have been a difficult and laborious one. Now it is greatly facilitated by the issue from the Colonial Office of those excellent little volumes, the reports of the Colonial Survey Committee.

This body has been in existence since August, 1905, and has published three annual reports. The Committee is therein defined as an advisory one formed at the instance of the Secretary of State for the Colonies to advise him in matters affecting the survey and exploration of British colonies and protectorates, more especially those in tropical Africa. It is not at present an executive body, that is to say it has at its own disposal no grant of public money or other funds; whether it will ultimately develop into such is a question that the future alone can answer. Even thus limited in scope and powers it has however already worked a notable improvement—firstly, by laying down authoritatively some of the more salient conditions that ensure the efficient and economical expenditure of whatever funds may be available, and by pointing out the disastrous extravagance of unsystematic and unmethodical work; secondly, by insisting upon uniformity where uniformity is essential, such as in matters relating to the style, projection, scales, and sheet-lines of the maps produced, while leaving the utmost latitude as to methods, these being selected in each case to suit the very divergent nature of the country met with. It results from this that any two small portions of the map of Africa, say, for instance, one sheet of the dense forest region of the Gold Coast and another of highland country of East Africa, though 3,000 miles apart and executed at different times by a different staff, will match each other in general character, and will ultimately be found to fit exactly into their places as constituent parts of a great map of the country; thirdly, we may reckon the mere fact of publicity in these matters as of no mean advantage. Though, as in the case of many other Government publications, this report is not as widely read as its merits deserve, yet it is all to the good that the information is there ready and available for anybody who has the curiosity to consult it. I therefore welcome the opportunity of drawing your attention to this volume.

In entering upon the discussion on the survey of British Africa, the first point that meets us is the geodetic basis of the whole work; upon what do the actual positions depend? In other words, to put the matter more familiarly, how are we to provide that every isolated piece of the map will exactly fit into its proper place? The only method for ensuring this is by basing all our surveys, ultimately, upon a skeleton or framework of geodetic or primary triangulation executed with the utmost attainable precision. Such a skeleton, or rather backbone, will eventually exist in Africa in the shape of the meridional arc, or chain of triangles, along the 30th meridian, running right through the country from north to south, and ultimately joining on to the great arc observed by the famous astronomer Struve. This originally extended from the mouth of the Danube to Hammerfest, in Norway, an amplitude of $25\frac{1}{2}°$ of latitude. To prolong it southward, passing up the Nile Valley, through the heart of tropical Africa, across the Zambezi River, and terminate it at the southernmost point of the continent, is a magnificent conception due to Sir David Gill, to whose energy and enterprise the actual execution of considerable sections of the undertaking must also be ascribed.

At the present time the chain has been completed from the south to within 70 miles of the southern end of Lake Tanganyika, a distance of about 1,700 miles. At Lake Tanganyika it will enter into German territory. The German Government, fully recognizing that the project is not only of great theoretical interest, but also of immediate practical value, are already taking steps to start work on their own section, from the south of Tanganyika up to the parallel of 1° south latitude. From 1° south, northward to about $1\frac{1}{2}$° north, the arc lies near the boundary between the Congo Free State and the British Protectorate of Uganda. An International Commission is at present engaged in the survey of the boundary region, and Sir D. Gill,* ever ready to seize an opportunity of forwarding the work he has at heart, succeeded in raising sufficient funds, partly from the Treasury and partly by grants from a few leading scientific societies, to enable an observer to be sent out with this Commission to carry the arc over this section. North of this point the line comes into the territory of the British Soudan, and traversing this, eventually reaches Egypt proper. Here it comes into the charge of Capt. H. G. Lyons, the director of the Survey Department of Egypt, under whose care its interests are safe. * * *

With regard to the section joining Africa and Europe the position is not so happy. This will run through Palestine and Asia Minor, and therefore lies in Turkish territory. It is not likely that the Turkish authorities either will or could carry out such a work; in fact, seeing that even when completed it would be totally useless to them, it would be hardly reasonable to expect them to do so. It must therefore presumably be a matter for international co-operation. * * *

When we look back a few years and call to mind the prominent part that this country has taken in the survey of Palestine—I need only mention in this connection the names of Kitchener, Warren, and Conder—we cannot avoid a feeling of regret that we are not ourselves in a position to take the whole execution of this section of the line upon our shoulders. I am too well aware of the many urgent claims upon the Treasury to suggest that it is possible that they would be prepared to incur such a charge; but supposing, for the moment, that part of the necessary funds could be provided from other sources, I think we may fairly urge that it is our duty to contribute a substantial monetary grant towards the furtherance of an end so desirable and so practically useful. * * *

* *Note by Editor.*—This was, as a fact, undertaken at the suggestion of the Secretary of State for the Colonies.

If we take the map of Africa we shall see that the arc along the 30th meridian passes through, or near, all the colonies of British South Africa, close to British Central Africa, or Nyasaland, through Uganda, and is thus connected with British East Africa, through the British Soudan and through Egypt. There remain absolutely untouched by it only the West Africa colonies—Nigeria, the Gold Coast, Sierra Leone, and the Gambia. These latter will eventually get their geodetic framework by an extension southwards of the French triangulation of Algeria, a work of a high order of precision. We are therefore entitled to say—and I take this opportunity of saying it with all due emphasis—that with the exception of some triangulation to join the West African colonies with the French triangulation, the arc along the 30th meridian is the only primary triangulation required for the adequate mapping of the whole of British Africa. The remainder of the geodetic framework can be supplied by ribs of secondary triangulation branching out from the main backbone, such as the line already completed along the boundary between British and German East Africa, passing to the north of the Victoria Nyanza and thence westward to the 30th meridian. * * * You will observe that I here speak only of the triangulation required for mapping purposes, not of that demanded by the geodesist for the study of the figure of the earth. It cannot be other than a very long period before the whole of Africa is surveyed upon such a scale of accuracy, and in the meantime we must devote ourselves to the far more urgent duty of mapping the country, leaving the more remote and abstract task to our descendants, well satisfied if in our hands the foundations have been well and truly laid. * * *

Having thus passed in brief review the ultimate geodetic basis of our African surveys, let us enter more into detail and glance at the actual survey work now in progress in the different regions of the continent.

In British South Africa, as we have already noted, the political conditions are at present unfavourable to any comprehensive scheme of operations. There is however in progress a first-class topographical survey of the Orange River Colony and a reconnaissance survey of Cape Colony. The former is an excellent example of the class of work that can be done by a small military party of the highest technical training working upon systematic lines, and I should like to devote a few minutes to a short description of the methods adopted and of the results obtained.

The survey party consists of two Royal Engineer officers and four non-commissioned officers, the former undertaking the triangulation and the general supervision of the field work, and the latter the plane tabling. The positions are primarily based upon the points of the geodetic survey broken up into a secondary triangulation, with sides averaging 10 miles. In 1907 the average triangular error of the secondary work was 2·9 seconds of arc, and the greatest linear errors of displacement, as tested by the geodetic triangulation at the end of a chain 45 miles long, were 3 feet in latitude and 2 feet in longitude. The probable error of a trigonometrical height was under a foot. You will see therefore that the accuracy is ample for all mapping purposes, even upon large scales, and the degree of precision is in excess of that demanded for a topographical map on the scale of 2 miles to an inch. The rate of progress and the low cost of work are however no less notable than its accuracy. The actual rate of out-turn is about 8 square miles per day per man, or for the whole party 23 square miles of detail survey per diem, and the number of trigonometrical points fixed about 300 per annum. The cost works out to about 8s. per square mile of the completed map, and the whole area of 47,000 square miles will be finished, printed and published, in 5½ years.

These remarkable results are due in a large measure to the energy and organizing power of the officer in charge, Capt. L. C. Jackson, R.E. The detail survey is done in sheets 15 minutes square, each non-commissioned officer being given one complete sheet, which he works at until finished. Four such sheets are therefore in progress at any given time, and each sheet takes about six weeks. Seeing the rapid rate of progress maintained, it might perhaps be thought that the country is a particularly easy one for the topographer. Such is however by no means the case. It is true that there is an entire absence of the surveyor's greatest impediment, large areas of dense forest, but there is much broken and difficult country, rising in places to altitudes of above 7,000 feet.

In Cape Colony the reconnaissance survey is of a somewhat similar character, but owing to the large area of the country and to the small amount of money available the work has perforce to be of a more rapid nature. In Natal, Bechuanaland, and Rhodesia no survey is at present in progress.

Passing northward through Africa, we come to the British Protectorate of Nyasaland, formerly called British Central Africa. Of this country a certain number of maps exist purporting to give topographical detail; but as they are not based upon any framework of triangulation, and as much of the detail only depends upon rough sketches, it is impossible to say how far they can be accepted as correct representations of the ground.

It is most unfortunate that financial considerations prevent the execution of any systematic trigonometrical survey. The absence of such, and the fact that maps are being made which must inevitably be withdrawn and replaced by others in the future, will undoubtedly be the cause of ultimate waste of money.

Passing northward again, we come to the large and important protectorates of British East Africa and Uganda, in both of which systematic surveys are in hand. The geodetic framework is supplied by a triangulation along the Anglo-German boundary, connected with chains of triangles along the railway in the neighbourhood of Nairobi. In Uganda proper there is also a triangulation covering a substantial area. As already noted, all this work will eventually be tied into the 30th meridional arc, though it is not likely that the final adjustment of geodetic positions thus arrived at will necessitate any substantial alterations upon the maps.

In both protectorates topographical surveys are in hand, and maps on the scale of 2 miles to an inch will be issued. In British East Africa, under the able direction of Major G. E. Smith, R.E., rapid progress is being made. This topographical mapping is additional to the cadastral maps also in progress in both countries. These latter are required for property purposes, in Uganda for demarcating the estates given over to the native inhabitants of the country under the agreement of 1900, and in East Africa for attachment to title-deeds of lands alienated for farming or stock-raising.

In the Soudan the enormous area of the country—over a million square miles—and the limited funds available have prevented any systematic survey being taken up. A large amount of reconnaissance mapping has been done, and a series of sheets on the scale of 1/250,000 (4 miles to an inch) have been published. These are corrected and improved by officers and Government officials as opportunity offers. The energies of the Survey Department* are almost entirely spent in meeting urgent local requirements in the shape of cadastral maps of the cultivated areas along the river.

Somaliland, a British protectorate which came into unfortunate prominence a few years ago, is a country of too small value to be worth the cost of any sort of survey, and the only maps that exist are based upon the route sketches of travellers and sportsmen, and upon the work done by a small section of the Survey Department of India during the military operations five years ago.

Leaving the east side of Africa, and turning our eyes westward, we may note that in the colony of the Gold Coast a rigorous survey was rendered imperative by the gold-mining boom of 1901. The work was entrusted to Lieut.-Colonel Watherston, C.M.G., R.E. Owing to the dense forest covering practically the whole country, triangulation would have been prohibitive in price and very slow in execution. The initial positions were therefore fixed by a network of long traverses, executed with all possible refinements with steel tapes and theodolites. Astronomical latitudes were observed by Talcott's method at every 50 miles. The errors of misclosure of the traverses proved to vary from about 1 in 2,000 in unfavourable cases to nearly 1 in 6,000—results inferior to triangulation, but at the same time sufficiently accurate to form the basis of a map with no appreciable

* Under Capt. Pearson, R.E.

errors *on the paper*. One great defect of the traverse method of fixing points lies in the practical impossibility of carrying the heights through without occasional checking, either by lines of levels or by trigonometrical observations. Such work makes therefore an imperfect basis for topography, and would only be used when natural features compel its adoption.

Northern Nigeria is a country of enormous area, and, up to the present, of small revenue. It has therefore not been found possible to allocate the funds for any systematic mapping. The existing maps are compilations based upon sketches made by civil and military officers when travelling upon duty, and upon the surveys made by the different Anglo-French and Anglo-German Boundary Commissions. In 1905–6 Capt. R. Ommanney, R.E., fixed the astronomical longitudes of 15 towns by exchange of telegraphic signals with Lagos. With the aid of these values, combined with a number of astronomical latitudes, it has been possible to combine the material into something like a complete map. It need however hardly be pointed out that astronomical fixations are liable to large and uncertain errors, due to the variation of local attraction, and cannot attain the precision of even a rapid triangulation. In Southern Nigeria the experience has been somewhat unfortunate. This colony has spent a very substantial sum upon its survey department, and if the work had been properly organized and systematically carried out we should by now be in possession of a complete map of a large portion of the country. Unluckily, the mistake has been made of detaching survey parties for non-geographical purposes, such as the erection of telegraph lines, work doubtless urgently required in the interests of the colony, but not lying within the sphere of a survey department. Thus systematic progress was rendered impossible, and though isolated pieces of triangulation and long lengths of traverses have been done, no topographical map of any area yet exists.

Of the remaining West African colonies, the Gambia River is a narrow piece of land with boundaries running parallel to the river banks, and, except for the actual trade along the river, is unimportant. In Sierra Leone the country in the immediate vicinity of Freetown was surveyed by the Colonial Survey Section, a small party employed by the War Office for the purpose of making surveys of places of special military importance. The map of the remainder of the colony is a compilation based on miscellaneous material.

In the course of this summary of the state of the mapping of British Africa mention has been made of the surveys made by joint commissions appointed for the delimitation of international frontiers. No small part of the existing map is due to work of this class. Thus joint Anglo-French Commissions have marked out the frontiers of the Gambia, Sierra Leone, the Gold Coast, and Nigeria; Anglo-German Commissions, the eastern boundary of Nigeria, the boundaries between

British and German East Africa, between German East Africa and North-East Rhodesia from Lake Nyasa to Tanganyika, and between Bechuanaland and German South-West Africa; Anglo-Portuguese Commissions, the frontiers between Portuguese East Africa and North-East Rhodesia and Nyasaland respectively. Useful surveys have also been made in the course of the mutual demarcation of the frontiers between Abyssinia and the Soudan on the west and British East Africa on the south; also of the frontier between the colony of Sierra Leone and the Republic of Liberia.

Important as the work done by these Commissions has been, its value would be greatly enhanced if the reports of each Commission were published in a succinct and easily accessible form. Such reports would naturally contain a record of the actual frontier as finally ratified, and also a technical account of the survey methods employed. They would thus be of permanent use both to the official or officer on the spot for the easy settlement of any disputes that may arise, and to the chief of any future boundary commission as an aid to the selection of the methods of survey most suitable to the particular country with which he is concerned.

Up to three years ago many of the African protectorates were under the tutelage of the Foreign Office, while the older colonies were under the Colonial Office. The reports of Boundary Commissions are therefore scattered through official documents in the two offices, and are drawn up upon no uniform model. Now that the superintendence of all these territories has been handed over to the Colonial Office, and that body has set itself such an excellent example in the appointment of the Colonial Survey Committee and the publication of its reports, it is greatly to be hoped that they will follow up the good work and systematize and publish all these Boundary Commission reports. If a model for such a publication is desired, I may refer to the account of the demarcation of the Turko-Egyptian frontier between Rabah on the Mediterranean to the Gulf of Akaba, lately issued by the Egyptian survey. * * *

The geographical survey of the British Empire, apart from Africa, will not on this occasion detain us long. I exclude from present consideration the great self-governing colonies—Canada, Australia, and New Zealand—and also the whole country lying within the sphere of the Survey of India. Ceylon has an elaborate land survey system; and though, owing to past mistakes, the geographical mapping of the island is in a most lamentably backward condition, there are good grounds for hope that this state of affairs will be remedied in the near future. The Malay States, where, owing to the fertility of the soil and the ubiquity of rich tin ore, the land values are high, have the basis of an excellent survey system, and possess a backbone of triangulation which will eventually extend southward to Singapore, and possibly northward to join the Indian series in the south of Burma. Hong Kong, including the leased territory on the mainland, is of small area and of no appreciable geographical importance. It has been adequately mapped for military purposes. Of our insular possessions, Mauritius, St. Helena, and (in the Mediterranean) Cyprus and Malta, are thoroughly surveyed. The other islands scattered throughout the ocean which fly the Union Jack, including the West Indies, while their coast lines have naturally been the subject of close attention by the Hydrographic Department of the Admiralty, are, as regards their internal geographical features, still quite imperfectly known. The large and important territory of British Guiana is entirely unsurveyed, and indeed in part almost unexplored.

You will thus realize that if we are prepared to admit the validity of the premiss that the mapping of its own territory is an imperative duty of a State which aspires to justify itself before the nations as the possessor of a world-wide Empire, there is still plenty of employment for the scientific geographer in the British dominions. * * *

In concluding this address I feel constrained to apologize for what may have appeared to some of you the dull and unromantic character of my theme. I am too well aware that to many the idea of geographical advance is confined to the perilous traversing of virgin lands, to the navigation of unknown waters, and to the penetration of forests or deserts never yet trod by white men's feet. I am conscious that the substitution of the surveyor for the explorer has necessarily destroyed much of the old romance, and that the feelings born when any fraction of the earth's surface was for the first time opened to our ken can never be revived. While however the romance has gone, the dangers remain, and there is as much call now for unflinching courage and for unselfish devotion to duty as there was in the days when the search for the sources of the Nile was an impelling cause sending adventurous men into the unknown. Whether occupied in cutting his way through the almost impenetrable forests of the Gold Coast or struggling with the papyrus swamps of the Nile basin, or whether, standing upon the top of some old volcanic hill, he is engaged in scanning the blue distances of the great Rift Valley, the surveyor is not less worthy of your admiration than the earlier traveller whose name is perhaps honourably enshrined in that of river or mountain. Whether pushing his way through the jungles of the Malays or floating upon the muddy stream of an African river, whether he is braving the attacks of savage animals, of treacherous natives, or the far more insidious assaults of the germs of some deadly disease, he is equally deserving of your sympathy and your encouragement. He is in truth a shining example of the power of that spirit of adventure and thirst for information which has carried our race so far in the past, and which in the future is, we all trust, destined to lead us ever "upwards and on"; the spirit that esteems no sacrifice too great in the cause of duty, and recognizes no duty so high as that of making some contribution towards the increase of natural knowledge.

THE R.E. HEADQUARTER MESS.

(*Continued*).

By Lieut.-Colonel B. R. Ward, R.E.

The main portion of the collection of pictures and busts in the Headquarter Mess is located in the Mess Room itself.

At the east end of the room is an impressive portrait of His Majesty the King, painted by Mr. H. Macbeth-Raeburn after the State portrait by Luke Fildes.

In 1904, on the death of H.R.H. the Duke of Cambridge, His Majesty paid the Corps the very great honour of becoming its Colonel-in-Chief in his stead. The announcement was made in the *London Gazette* of the 2nd May, 1904, and reads as follows:—"The King has been pleased to confer upon the Royal Regiment of Artillery and the Corps of Royal Engineers the honour of becoming their Colonel-in-Chief.—Dated 1st May, 1904."

Consequent on this announcement, it was decided at the Annual Corps Meeting of 1904, to commemorate this honour by procuring for the Mess a portrait of His Majesty. Sir R. Harrison interviewed Sir Luke Fildes, and obtained permission from him for Mr. Macbeth-Raeburn to make a copy of his famous State portrait.

The picture is flanked on the north side by one of George Augustus Eliott—Lord Heathfield—and on the south side by a magnificent portrait of Lord Napier of Magdala.

Lord Heathfield's picture is an excellent copy, made by Miss Kate Morgan, of one of Sir Joshua Reynolds' most famous portraits in the National Gallery. It was presented to the Mess in 1877 by Lieut. C. M. Watson, R.E., and represents Lord Heathfield as holding a key, commemorative of his defence of Gibraltar against the combined French and Spanish forces from 1779 to 1783.

Lord Heathfield's connection with the Corps dates from his appointment as Practitioner Engineer in 1741 to his resignation of his Engineer's Warrant in 1756. It was not until 1757 that military rank was granted to the Corps of Engineers, Lord Heathfield having in the meantime risen by means of steps in the Royal Artillery and Horse Grenadier Guards to the rank of colonel. His services in the War of the Austrian Succession from 1742 to 1748, where he was present at Dettingen and Fontenoy, and his brilliant career at the head of his light cavalry regiment (named after him Eliott's Light Horse, now the 15th Hussars) in the Seven Years' War (1756—1763), were eclipsed by his conduct of the famous defence of Gibraltar from 1779 to 1783. At the conclusion of peace he was made a Knight of the Bath, and was raised to the peerage in 1787 as Baron Heathfield of Gibraltar. He died at Aix-la-Chapelle in 1790.

The portrait of Lord Napier is by Lowes Dickenson, and is one of the best original portraits in the Mess. Technically it is a fine piece of work, the face especially being full of character. It represents Lord Napier, in the uniform of a Field Marshal, holding in his hands a bunch of keys, indicative of his office as Constable of the Tower.

The chief portraits in the north annexe of the Mess Room are those of Sir Charles Pasley, Sir John Burgoyne, and Sir William Denison.

Sir Charles Pasley and Sir John Burgoyne both obtained their first commissions in 1798, the former being the senior by some five months. Sir Charles Pasley is best known by his work as founder of the R.E. Establishment in 1812, and as its Director for nearly 50 years. His work in connection with this Establishment has been fully dealt with in the February and March, 1908, numbers of the *R.E. Journal*, and full details of his life will also be found in the *R.E. Professional Papers*, New Series, Vol. XII., *The Dictionary of National Biography*, and Porter's *History of the Corps*.

Sir John Burgoyne is endeared to all R.E. officers beyond any other name in their history, on account of his great services to the Corps during his unprecedented service of 70 years.

It was not until 1868 that he resigned the office of Inspector-General of Fortifications, at the age of 86, and his statue by Boehm in Waterloo Place most appropriately bears the quotation from Coriolanus, Act II., Scene III. :—

"How youngly he began to serve his country, how long continued."

His war services began at Malta in 1800, and closed in the Crimea in 1855. Sir Francis Head, who wrote his memoir in the *R.E. Professional Papers* for 1872, heads his Paper with the following anecdote :—

"Not many months ago, at a dinner party in London, an old officer said aloud and emphatically to a much older one, '*You* have done more under fire than any soldier in Europe!' 'Well,' replied the accused, in a tone of mild apology, 'but remember I have been *a long time about it*.'"

Needless to add the "much" older officer referred to was Sir John Burgoyne. He was senior officer of Engineers serving at the close of the Peninsular War in 1814, and forty years later—in his seventy-fourth year—he was serving as C.R.E. before Sebastopol.

Sir John Burgoyne died in 1871, "in the portal of his 90th year," just one year after his son, Capt. Hugh Burgoyne, V.C., R.N., went down with his ship—the ill-fated *Captain*—during a gale in the Bay of Biscay.

The Military Opinions of Sir John Burgoyne, published in 1869, the memoir by Sir Francis Head referred to above and subsequently enlarged and reprinted in book form, and the *Life and Correspondence of Sir John Burgoyne, Bart., G.C.B.*, published by his son-in-law, Lieut.-Colonel the Hon. George Wrottesley, R.E., all remain as monuments of his *esprit de corps*, sound sense, and unfailing judgment, as well as of his long-continued and distinguished services to the country.

A bust of the fine old Field Marshal occupies a niche above his picture, the portrait of Sir Charles Pasley being surmounted by a similar bust of Sir John Jones.

The west end of the north annexe is occupied by a full-length portrait, by Charles Lutyens, of Major-General Sir William Denison. This portrait is due to the action of Sir Andrew Clarke, who had served as private secretary under Sir William Denison when the latter was Governor of Tasmania, or Van Diemen's Land as it was then called, from 1849 to 1853. When he came to Chatham as Commandant of the S.M.E. in 1881, he was surprised to find no suitable memorial in the Mess, to his old friend and chief, the originator and first editor of the *R.E. Professional Papers*.

The outcome of his advocacy of the matter at the Corps Meeting of 1882, was the portrait now hanging in the Mess, which was copied from old prints and photographs. Many references to Sir William Denison will be found in Colonel Vetch's *Life of Sir Andrew Clarke*, and few who study Sir William's career and personality will be disposed to dissent from Sir Henry Harness' verdict that he was "one of the most excellent among us."

Sir William Denison is represented in diplomatic uniform, his chief title to fame being his admirable work as Governor successively of Van Diemen's Land, New South Wales, and Madras.

For a short period in 1863, on the death of Lord Elgin, he was also acting Viceroy of India, and on that occasion "rendered a valuable service by procuring the recall of an order for the withdrawal of the troops, then engaged in the Sitána Expedition, a measure which, following as it did a temporary check sustained by the British force, could not have failed to affect injuriously our military prestige, and would probably have set the whole frontier in a blaze."*

In 1866 he returned to England as a colonel in the Corps, and was appointed C.R.E. at Portsmouth. "It is not necessary," writes Sir Henry Harness in his interesting memoir† of his old friend, "to recall the pleasure with which his brother officers received him on his return, and anticipated his being again employed among them; nor their gratification when they heard that His Royal Highness the Commander-in-Chief had offered him the Royal Engineer Command

* *Dictionary of National Biography*, Vol. XIV., p. 357.

† *R.E. Professional Papers*, 1872, Vol. XX., New Series, p. xix.

at Portsmouth, and that he had gladly accepted it. The appointment, however, did not take place, and his letter in reply to the communication from the Inspector-General of Fortifications, which informed him that it was not considered right to send him to that duty after the high positions he had held, is so characteristic, that his friends and brother officers must wish it to be recorded in these pages.

'United Service Club, 1st July, 1867.

'My dear Sir John,

'I am much obliged to you for allowing me to see His Royal Highness's letter on the subject of my appointment as Commanding Royal Engineer at Portsmouth. I feel grateful to His Royal Highness for the testimony borne by him to the mode in which I have performed the duties incidental to the various positions in which I have been placed. I cannot but think, however, that the motives which have actuated me throughout my career have been misunderstood, and feelings alluded to, as likely to arise out of the inferiority of my present position, or of my possible future one, to those which I have held, which neither have found, nor will find a place in my mind.

'I have always had a strong Corps feeling, and have ever considered my position as an officer of Engineers an honourable distinction. I have done my best to qualify myself for the various duties which, as an officer of Engineers, I might be called upon to perform; and I have striven to induce my brother officers to take the same view as myself of the very varied character of their duties. How varied these have been in my case you know very well, but the variety was not the result of any application on my part. The offer of employment, other than that of the ordinary duties of the Corps, in every case came spontaneously from persons in authority, and I accepted the offer feeling myself competent to execute the works entrusted to me, and with a conviction that in so doing I was but acting up to my duty as an officer. I never looked upon the appointments I held as permanent; indeed they were essentially of a temporary character, and though I have been moved from one government to another, I have always looked forward to the time when I could rejoin my Corps, and as a matter of course re-assume my military position. His Royal Highness is aware that in 1865, when the question was put to me whether I intended to resign my commission, I distinctly stated that such was not my intention, and that I held myself in readiness to obey any orders I might receive from His Royal Highness. I did not then, neither do I now, think, that in re-assuming my position as a Colonel of Engineers, after having acted as a governor or governor-general, I have in any way lost caste; or that in performing the duties incidental to an officer of my rank and standing, I can be considered to be doing anything derogatory to myself—on the contrary, I feel that a refusal on my part to accept the realities of my position, and to perform my duties as an officer, would be equivalent to an admission that I was incapable or unfit to do so; and this most certainly I am not in any way disposed to allow. My opinion is that in returning as a matter of course to my ordinary duties in the Corps, I have but acted in accordance to a sense of duty, and as I should wish to see my brother officers do: that they appreciate my motives and are glad to see me back amongst them I have every reason to believe. Such being my feelings, and those of my brother officers, I, when asked by the Deputy Adjutant General whether I would accept the command at Portsmouth, replied at once in the affirmative; indeed I could not act otherwise, and I trust that His Royal Highness will admit that, under the circumstances, no option was left to me, and will appreciate my wish to resume my military duties.

'Believe me,

'Yours very truly,

'(Signed) W. DENISON.'"

Sir William's work, as the originator and first editor of the *R.E. Professional Papers* in 1837, has been already alluded to in the April number of the current year's *R.E. Journal*, page 229; and his work in the Survey School is referred to in the May number of the *R.E. Journal*, page 301.

Few men have done more work for the Corps, or shed more lustre upon it. "His life," writes Sir Henry Harness in the memoir already alluded to, "is an example to us and to those who are coming after us. In every passage of that life we have reason to be gratified with our brother officer, and when we regard the whole of it, we cannot but desire to preserve the memory of his career as that of one of the most excellent among us."

On the west wall of the Mess Room, facing the portrait of His Majesty the King, are two full-length portraits of Queen Victoria and the Prince Consort, painted for the Corps by Kobervin after F. Winterhalter. The originals are in one of the Royal Collections.

I have been hitherto unable to discover when these two copies were painted, but in all probability they date back to the period of the Great Exhibition of 1851, an enterprise in which the Corps played an important part.

The Prince, who had projected the idea of an International Exhibition as far back as 1849, met with great opposition in carrying his idea into effect. It was feared that a display of England's manufacturing pre-eminence would lead to a spirit of competition amongst other nations, which might in the end tell formidably upon the prosperity of the country.

The appointment in 1850 of Lieut.-Colonel W. Reid, R.E., to the

Chairmanship of the Executive Committee of the Exhibition, saved the Prince from much anxiety in reference to the scheme which he had so much at heart. Lieut.-Colonel Reid, who obtained the assistance of many of his brother officers, as well as of the rank and file of the Corps, in the construction and organization of the Exhibition building—now the Crystal Palace—was rewarded, after the triumphant success of the Exhibition—the forerunner of so many subsequent International Exhibitions—with a civil K.C.B. in 1851.

The service thus rendered by the Corps was never forgotten by the grateful Prince, and although he was never our Colonel-in-Chief, it is fitting that we should have a permanent memorial of one whose name was so closely associated with the rise of the Corps into prominence in the middle of the last century.

NOTE.

As a result of the Notice regarding Sir Harry Jones' sword inserted on page 95 of last month's *Supplement*, I have received the following version of the story from Major-General Sir William Salmond, K.C.B. Sir William heard the details from the painter of Sir Harry Jones' portrait, Mr. E. U. Eddis, who got the account from Sir Harry himself when the latter was sitting for his portrait. The story now reads as follows :—

After the words in line 29 of page 270 *ante*, "last surviving son of Sir Harry Jones," *dele* the remainder of the paragraph and read as follows :—

"Sir Harry was the Engineer officer who led the first unsuccessful assault on San Sebastian. He was wounded in the breach and taken prisoner. At the time of the second and successful assault he was in hospital. He heard a great commotion outside, and knew from the cheers that the British were in the street. The shouts and cries of combat came closer and closer ; there was a rush up the hospital stairs, and a French officer ran in, escaping from his pursuers. Sir Harry jumped out of bed, said 'All right ; I will save you !' seized the French officer's sword, buckled on the scabbard, and interposed between the Frenchman and the British. He declared himself a British officer, and that the Frenchman was his prisoner. By this means he saved the French officer, and doubtless all the inmates of the hospital, as well as the hospital itself, for the times were rough, and when a place was sacked in those days, fire and sword were impartially merciless."

VOLUNTEERS OF THE 18TH CENTURY.

By LIEUT. G. A. BROWN, COAST BATTN., R.E.

IN last month's *Journal*, the copy of a document was given as being probably one of the first to refer to Volunteers for Harbour Defence Work.

In the R.E. Office at Gravesend the following correspondence is recorded, and it shows that not only were the Dover Volunteers anticipated at Gravesend, but also that the credit of raising and training them was due to Lieut. Shipley, the Engineer officer in charge of the communications there.

The bargemen who formed this early Volunteer Corps were men employed "on the cheek," but whether they ever received the "pecuniary gratification"—mentioned in Lieut.-Colonel Debbieg's letter—is not recorded.

No. 1.

GRAVESEND *March the* 13*th* 1780.

DEAR SIR,

A consideration of the very great advantage that might probably arise to the Service, from having the Bargemen trained to the working of Artillery, particularly with a view to their Manning the Batteries at this Place on any occasion, induced me to sound the inclinations of the People on the Subject, and I have the pleasure to inform you, that they Unanimously Expressed their readiness and desire to be Employed in this double Capacity, 'tis only necessary for me to say further, that the Effecting this purpose will not be attended with the smallest Expense, and that I will undertake in a very short time to make them sufficiently expert, either with, or without the assistance of a small Party of Artillery Men, when this matter is determined upon, it may perhaps be worthy of Consideration, whether it would not be more advantagious to Work the Guns with Tackles, in like manner as on Board of Ship, than in the usual manner with Handspikes.

o o o o o

I am Dear Sir
Your Most Obedient and Most Humble Servant
CHARLES SHIPLEY.

LIEUT.-COLONEL DEBBIEG.

No 2.

LONDON *March the 15th* 1780.

DEAR SIR,

Lord Amherst has approved of the Bargemen being Employed at the Exercise of the Great Guns, but a Party of Artillery Men cannot be had, so if you make any progress therein, you will have all the Credit of it to yourself.

If the Men persevere and become Expert at the Business, I have no doubt but his Lordship will order them some pecuniary gratification for their trouble.

I am Dear Sir
Your Most Obedient Humble Servant
HUGH DEBBIEG.

LIEUT. SHIPLEY.
Gravesend.

No. 3.

GRAVESEND *March the 20th* 1780.

DEAR SIR,

I deferred acknowledging the Receipt of your Letter of the 15th Instant, till I had it in my power to acquaint you that the Bargemen who are this Week upon full Pay, have already made such progress in their New Employment, as to convince me that a very short time will make them as Expert as can be desired. Under this perswasion, I am therefore to request, that as soon as I shall Report to you that the whole are perfect in the manner of Loading, Firing, laying, and otherwise Working the Garrison Guns, that you will take the trouble to see them perform, and that you will then Report as you think they deserve.

I am glad to tell you that we scarcely feel the want of the assistance of a Party of Artillery Men.

I am Dear Sir
Your Most Obedient and Most Humble Servant
CHARLES SHIPLEY.

LIEUT.-COLONEL DEBBIEG.

No. 4.

GRAVESEND *March the 26th* 1780.

DEAR SIR,

o o o o o

Three of the Bargemen who were upon full Pay the last week, are as expert in the working of the Guns, as can be desired, and I have no doubt, but that the remainder will be so in a fortnight, this business having Succeeded So well hitherto induces me further to propose, that the People should be trained to the Exercise of the light Artillery in order to render them of the most general utility possible in the Defence either in the Field, or in Garrison of any part of this Country should it be invaded. I am therefore to request (should this proposal meet with your approbation) that you would apply for Two Six Pounder Field Pieces compleat to be sent as soon as possible to Gravesend, for the purpose of my instructing the Bargemen in the use of them, the very small number of Artillery now in the Kingdom renders it an Object of the utmost importance to supply the want of them by every means possible, and the accomplishing this purpose in the present instance, so as to have (when the high Establishment takes place) Ninety able-bodied Men, well trained to the Exercise of Garrison and Field Artillery, will be attended with little or no Expense, will not at all interfere with any other part of their Duty, and so far from creating any degree of Jealousy in their minds, that I can with Confidence affirm from their own volantary Declaration that they are so sensible of the Comforts and attention afforded them by Government, they shall rejoice in the occasion of exerting themselves to the utmost of their power in the performance of any Duty allotted them,

The Field Pieces may be sent from the Tower to Gravesend by Water, and returned when done with (by the same conveyance) with little trouble or Expense.

With respect to what I mentioned of the Working of Guns with Tackles as on Board of Ship, I find upon Tryal that Handspikes as being more simple, have in general the advantage, and best adapted to a Mixture of People, who might on any occasion be Joined with the Bargemen,

The Protections for the Ensuing Fortnight Arrived Yesterday.

I am with the greatest Regard Dear Sir
Your Most Obedient and Most Humble Servant
CHARLES SHIPLEY.

LIEUT.-COLONEL DEBBIEG.

No. 5.

GRAVESEND *April the 27th* 1780.

SIR,

I am now to report to you that the whole of the Bargemen on the present Establishment are as Expert in the Exercise of the Great Guns as can be desired, I should be wanting in common Justice to them, was I to omit assuring you of the Alacrity and good Humour with which they undertook and have gone through this Extra Duty. The accomplishing of this Business has been attended with the Expenditure of a small Quantity of Powder, I believe about Eight Barrels in the whole, which was furnished by Mr. Aked at my particular instance, which I flatter myself will be thought a trifling Consideration, in comparison to the benefits that may arise from the Bargemen being so taught.

o o o o o

I am Sir
Your Most Obedient Humble Servant
CHARLES SHIPLEY.

LIEUT.-COLONEL DEBBIEG.

TRANSCRIPT.

THE FRENCH AND ITALIAN BRIDGING TRAINS.

(Transcript from the *Memorial de Ingenieros*).

In May, 1905, a Commission, composed of one colonel and one lieutenant-colonel of Engineers, was sent by the Spanish Government to report on engineer matters in France and Italy.

Their report has been published in a recent issue of the *Memorial de Ingenieros*, and is divided into two parts, the first dealing with barrack construction, and illustrated with numerous views and diagrams of barrack and hospital buildings, and the second with bridging material. The consideration of the first part is deferred to a later date, but the following is a somewhat condensed translation of the part relating to bridges.

The Commission was directed to report on the following subjects:—

1. Wheeled transport. (*a*). Vanguard bridging trains; their organization, composition, length of bridge, weight and loads of the vehicles on which the material is transported, total weight behind the teams, the teams and the tractive force required to be exerted by each animal.

(*b*). Army and Corps bridging trains. The same particulars as in (*a*), and in addition all details referring to their organization and its adaptation to the organization of the armies of France and Italy respectively.

2. Mountain bridging train. Its organization, composition, number of pack loads of which it is formed, weight of the loads, method of transport, and length of bridge which can be constructed by each bridging unit, special attention being devoted to the methods of forming the bays.

The Commission commences its report by a historical summary of military bridging. It divides the subject into eight periods.

First period, from the earliest times up to the 4th century A.D., in which the portable material consisted of light boats carried on pack animals. No superstructure was carried, the necessary material for it being taken from woods adjacent to the site of the bridge.

Second period, from the 5th to the 15th centuries A.D., during which portable bridging trains were unknown.

Third period, up to the middle of the 17th century, during which time military bridges were usually constructed of material locally available, though very heavy bridging trains were sometimes used.

Fourth period, from the middle of the 17th to the end of the 18th century, during which light bridging trains were introduced. The buoyancy of the points of support was diminished, as well as the weight of the superstructure. The results were at first unsatisfactory, and attempts were then made to increase the buoyancy by using metal instead of wooden supports. The Dutch were the first to use sheet-iron pontoons, and were soon followed by other nations. The backward state of the science of metallurgy prevented these experiments from attaining much success, with the result that portable bridging trains again became discredited.

Fifth period, from the end of the 18th century to the fall of the French Empire. Wooden pontoons of large dimensions were re-introduced. The Austrian pattern, intermediate in size between the heavy pontoons of the third and commencement of the fourth period and the light metal pontoons of the fourth period, was generally adopted.

Sixth period, from 1813 to 1840. Light pontoons similar to those of the fourth period were re-introduced. This proved to be a retrograde step.

Seventh period, marked by the introduction of the Birago pontoon, the invention of an Austrian lieutenant-colonel. This invention produced a veritable revolution in the composition of bridging trains, though the only thoroughly original feature was the two-legged trestle. The Birago material was accepted by most nations, subject to a few unimportant modifications.

Eighth or present period. Defects began to be found in the Birago material, and improvements in metallurgy enabled metal pontoons to be constructed with success. Two distinctive patterns have been evolved, the one in Sweden (the Normann system), the other in Denmark and Holland. The latter has preserved the Birago trestle with notable improvements, but has entirely altered and lightened the pontoon without in any way weakening it. Spain, Norway, Chile, and Argentina have adopted the Danish system, which the Commission considers to be far in advance of all others.

England has adhered to its material, characterized by a pontoon of canvas, wood, and cork, fitted with a saddle; Belgium retains the Thierry three-legged trestle, whilst France and Italy have, probably from motives of economy, retained their old equipment.

FRANCE.

A description of the organization of the French Engineers will be found in the *R.E. Journal* for August, 1908.

The Commission visited the bridging school of the detached battalion at Toul, on the Moselle, and that of the 7th Regiment during the manœuvres on the Rhone, between Vienne and Avignon.

1. WHEELED TRANSPORT.

(*a*). *Vanguard Bridging Trains.*

Up to the present France has not adopted a vanguard bridging train. At the same time it is recognized that the existing equipment is much too heavy and cumbrous, and is deficient in the mobility which has been acquired by all arms of the service. Experiments have therefore been made for the purpose of finding a more suitable equipment, and the matter has received much attention in the military press.

In the park of the 7th Regiment the Commission was shown the material proposed by Capt. Benard, of the French Engineers, for service with the cavalry.

The Benard material is transported on a four-wheeled wagon formed like a cage, that is to say, with high sides united by canvas bands between which are packed four metal pontoons of small dimensions, similar in type to the Swedish boats, and to the Spanish ones of the Monteverde system. Three of these pontoons are of equal size; the fourth is smaller, so as to admit of its being packed inside one of the former. The centre of gravity of the load is high, and there is great risk of the wagon upsetting on all but the best roads. The pontoons are packed one on the top of the other. The superstructure is composed of four baulks, chesses, saddles, and oars. The Commission do not consider it necessary to give the weights and dimensions.

The Very equipment was tried at Lunéville during the French manœuvres in August, 1906. The Commission did not have an opportunity of seeing it, but learnt that three canvas boats, which could be folded and carried on pack animals if necessary, were carried in each vehicle. The buoyancy is 1,500 kg. (3,300 lbs.). The superstructure, composed of baulks and chesses, is suitable for widths of roadway from 0·65 m. (2′ 2″) to 2·50 m. (8′ 2″). This information is sufficient for the Commission to be of opinion that the system is not one which is worthy of imitation, and that it is very unlikely that it will be adopted in the French service.

The exceedingly important reconnaissance duties entrusted to the cavalry have led to the idea of giving to that arm a means of crossing small streams and obstacles of a breadth not exceeding 20 to 25 m. (65′ to 80′), above which the regular bridging trains of the Engineers must be employed.

This idea seems a very plausible one, but it has not yet taken a practical form. Troops detached for reconnoitring purposes must necessarily be weak in number and incapable of much resistance, and as they require the maximum of mobility they cannot be encumbered with a number of vehicles. An attempt has been made to reduce the weight of these vehicles, but the only result has been to reduce very largely the efficiency of the material carried by them, so that it is but little better than that which might be found at the spot where a bridge had to be made. Its application in streams having a current exceeding 1 m. a second (about 2 miles an hour) would be either impossible or dangerous. It would generally be better either to ford or swim such streams rather than to use bridging material of insufficient strength. Flying bridges might often be of value, but a trained *personnel* is necessary for their use.

The Commission will not say that the problem is being abandoned, but it must be approached with great care and by persons thoroughly competent to deal with it. The Vanguard sections carrying 15 m. (15 yards) of bridge, which have been mentioned in the professional press, do not seem to exist in France.

(b). Bridging Trains.

In France there are army corps and army bridging trains.

The army corps equipment is organized in two divisions and a reserve.

Each division consists of—

	Vehicles.
1 superstructure section	2
1 trestle section	2
4 pontoon sections	12
1 field forge section	2
Total	18

The reserve section consists of 1 bridging and 1 store wagon. The corps bridging train therefore consists of 38 vehicles.

The superstructure section of the 1st Division contains one box of instruments, model 1877.

The field forge section consists of 1 forage cart, 1 field forge, and 1 wagon for smiths' tools, etc. Independently of these vehicles each corps bridging train has 6 supply wagons and 1 store wagon.

The army bridging train is formed of 2 corps trains, and consequently consists of 4 divisions and a reserve. Each of the divisions is organized similarly to those of a corps bridging train. The complete train is therefore composed of 76 vehicles. The auxiliary vehicles necessary for the service of the two park sections and for the transport of supplies and stores are the following:—2 field forges, 2 park wagons, 2 forage carts, 12 supply wagons, and 2 store wagons.

A corps bridging train can make 123 m. (134 yds.) of bridge.

The points of support are formed by single wooden pontoons, of which there are 16 in the train, and four Birago trestles. The wooden pontoons are being gradually replaced by metal ones of galvanized iron of the Prussian type, the ends being raised, so as to make anchoring less difficult. Legs of three different lengths are used in the trestles. In each bay of trestles there are two baulks with claws, used on the outside of the roadway; the remainder are plain.

The superstructure rests directly on the gunwales of the pontoons, to which the outer baulks, which are smooth and of a special pattern, are lashed.

The following table, taken from the official regulations, details the number, weight, distribution, etc., of the equipment of a corps bridging train:—

Detailed Composition of a French Corps Bridging Train.

Description.	Weight of the Unit.	Number.	Distribution. Reserve.	Super-structure Section.	Trestle Section.	Pontoon Section.	Field Forge Section.
Vehicles.	kg.						
Park wagons	919·00	15	1	2	2	8	2
Field forges	1102·00	2	—	—	—	—	2
Material wagons	914·00	21	1	2	2	16	—
Total ...		38	2	4	4	24	4
Supports.							
Pontoons	660·00	16	—	—	—	16	—
Two-legged trestles complete... ...	170·00	6	—	—	6	—	—
Each trestle consists of—							
1 transom ... ... kg. 98							
2 legs, 3 m. long ... ... ,, 40							
2 suspension chains... ... ,, 16							
2 shoes ... ... ,, 16							
Total ... ,, 170							
Boats	450·00	2	—	2	—	—	—
Superstructure.							
Saddles...	56·00	4	—	4	—	—	—
Chesses...	24·00	392	—	40	64	288	—
Baulks { for lashing	43·00	42	—	28	14	—	—
Baulks { clawed	44·00	16	—	—	16	—	—
Baulks { ordinary	55·00	119	7	—	—	112	—
Baulks { cut	14·00	14	2	12	—	—	—
Cordage.							
Lashings	7·50	64	16	12	4	32	—
Two-strand ropes	0·65	32	32	—	—	—	—
Lashings { rack	0·03	188	—	30	38	120	—
Lashings { small	0·40	180	—	30	30	120	—
Lashings { for baulks...	0·30	460	18	36	60	272	—
Anchor cables	43·00	22	—	4	—	16	2
Other cables	27·00	3	1	—	—	—	2
Tow-ropes { for horses	42·00	4	2	—	—	—	2
Tow-ropes { ,, men	5·00	10	—	2	—	8	—
Miscellaneous.							
Anchors	65·00	16	—	—	—	16	—
Ribands	8·00	12	—	2	2	8	—
Rack sticks	0·30	180	—	30	30	120	—
Suspension chains { long (12′ 6″) ..	4·50	12	—	2	2	8	—
Suspension chains { short (9′ 0″) ...	3·40	12	—	2	2	8	—
Spikes	0·50	40	—	—	—	—	40
Dogs	0·50	40	—	—	—	—	40
Lashing-chains, with wedges... ...	6·80	24	8	16	—	—	—
Jacks { large	46·00	1	1	—	—	—	—
Jacks { small	32·00	2	—	—	2	—	—
Balers { large	1·70	18	—	2	—	16	—
Balers { small	1.00	18	—	2	—	16	—
Tackle	15·00	1	1	—	—	—	—
Two-pointed boathooks { pontoon ...	5·70	80	—	—	—	80	—
Two-pointed boathooks { boat ...	4·25	6	—	6	—	—	—
Boathooks, with point and hook ...	5·50	16	—	—	—	16	—
Grapnels	15·00	2	—	2	—	—	—
Light boathooks	3·50	4	—	—	—	—	4
Apparatus for flying bridge	7·50	2	2	—	—	—	—
Winch	65·00	1	1	—	—	—	—
Pickets { large	9·50	24	—	24	—	—	—
Pickets { small	6·00	20	—	20	—	—	—
Pumps	11·55	4	—	—	4	—	—
Megaphones	0·50	2	—	—	—	—	2
Wooden blocks	7·00	4	—	—	—	—	4
Oars { pontoon	7·00	96	—	—	—	96	—
Oars { boat { ordinary	3·00	10	—	10	—	—	—
Oars { boat { bound with iron... ...	4·00	2	—	2	—	—	—
Rowlocks { for steering	0·30	72	—	8	—	64	—
Rowlocks { for rowing	0·10	180	-	20	—	160	—
Transoms	11·00	4	—	—	4	—	—

The equipment also includes tools, repairing materials, wire, topographical and drawing instruments, etc.

The weight of the metal pontoon is 685 kg.

LOADS OF THE VEHICLES.

Superstructure Section.

			Number.	Weight. Kgs.
Bridge wagon	Baulks		14	602
	Boat		1	450
	Lashings		6	1·80
	Saddles		2	112
	Boat-oars	ordinary	5	15
		iron-bound	1	4
	Boathooks		3	12·75
	Rowlocks	steering	4	1·20
		rowing	10	1
	Balers	large	1	1·70
		small	1	1
	Tools, etc.		4	—
	Total weight of loaded wagon			2210
Park wagon	Chesses		20	480
	Pickets	large	12	114
		small	10	60
	Anchor cables		2	86
	Warps		6	45
	Lashings	for baulks	22	6·60
		miscellaneous	15	6
		rack	15	0·45
	Various		—	—
	Approximate weight of loaded wagon			2110

Trestle Section.

Bridge wagon	Baulks		7	301
	Shore-end transom		2	22
	Trestle transom		3	297
	Lashings	ordinary	6	1·80
		with rack stick	4	0·12
	Legs	2 m.	4	52
		3 m.	6	120
	Shoes		6	45
	Suspension chains		6	48
	Baulks with claws		8	352
	Legs, 3·90 m.		4	108
	Various		—	—
	Approximate weight of loaded wagon			2270

Park wagon	Chesses	... ...	32	768
	Lashings	for baulks ...	24	7·20
		miscellaneous ...	15	6
		rack	15	0·45
	Shoes	... ...	1	7·50
	Warps	... ...	2	15
	Various	... ...	—	—
		Approximate weight of wagon		2160

Pontoon Section.

Bridge wagon	Baulks	... ...	7	385
	Pontoon	... ...	1	660
	Lashings	... ...	5	1·50
	Anchors	... ...	1	65
	Rowlocks	for oars ...	10	1
		„ steering ...	4	1·20
	Boathooks	with spike ...	5	28·50
		„ „ and hook ...	1	5·50
	Balers	large	1	1·70
		small	1	1
	Tools, etc.	.. ..	—	—
		Approximate weight of loaded wagon		2120

Park wagon	Chesses	... ...	36	864
	Anchor cables	... ...	2	86
	Warps	... ...	4	30
	Lashings	baulks	24	7
		miscellaneous ...	15	6
		rack	15	0·45
	Various	... ...	—	—
		Approximate weight of loaded wagon		2120

Field Forge Section.

Field forge	There are two marks of wagon, one of 1827, the other of 1827 improved. The first weighs 1,640 kg., the second 1,810 kg., and holds a larger amount of coal.
Park wagon	Various articles. Approximate weight, 2,030 kg.

Reserve.

Bridge wagon	.. ..	1870 kg.
Park „	... ...	2020 „

DESCRIPTION OF THE PARTS OF THE BRIDGE.

Vehicles.—Besides the field forge wagon, there exist two different types of vehicle, the park wagon for chesses (*charriot de parc*) and the pontoon wagon (*haquet*), both without springs and drawn by six horses. Their weight empty is 919 and 914 kg. respectively.

Pontoon (*Fig. a*).—Of wood, with iron fittings; total weight, 660 kg.; length, 9 m. 43; breadth over all, 1 m. 76; depth at centre, 0 m. 785.

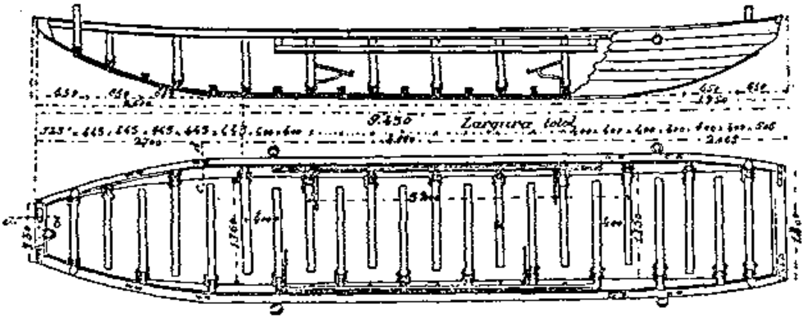


FIG. *a*.

A galvanized steel pontoon of German type is being introduced, with pointed ends, plating equally thick throughout. Its weight exceeds that of the wood pontoon by 20 kg.

Trestle.—Birago system. Trestle, length 5 m. 37, section 0 m. 20 × 0 m. 22 at the ends, and 0 m. 23 × 0 m. 16 elsewhere. Weight, 99 kg. Two legs 3 m. long, two legs 3 m. 90 long, and two legs 2 m. long.

Shoes of oak.

Inclination of the legs = 70°.

Boat, length, 9 m. 08; width at centre, 1 m. 57; depth at centre, 0 m. 49.

Anchor, of iron; weight, 65 kg.

Chesses, 3 m. 90 × 0 m. 933 × 0 m. 04.

Baulks.—With claws;	length,	6 m.,	section 0 m. 12 × 0 m. 12.
For lashing	,,	6 m. 30,	,, ,, ,,
Cut	,,	2 m.,	,, ,, ,,
Ordinary	,,	8 m.,	,, ,, ,,

Tractive Force.—As this is so variable, depending on the state of the track, for the same vehicle and team the Commission assumed:—

1. That for the same loads the tractive force is inversely proportional to the diameter of the wheels.
2. That the useful tractive force which each animal has to exercise, according as there are six, four, or three in each team, is relatively proportional to the numbers 7, 8, and 9.

For the French equipment we have the following data:—

Springless Wagon.

Weight of pontoon wagon	...	2120 kg.
,, park ,,	...	2020 ,,
Horses ...	...	6
Mean diameter of wheels { pontoon wagon	...	1·35 m.
{ park ,,	...	1·315 m.

Therefore, dividing the weight of the loaded vehicles by the number of horses, by the mean diameter of the wheels, and by 7, as there are six horses in the team, and multiplying the quotient by 5, as the vehicle is without springs, we obtain as coefficients of traction—

For the pontoon wagon, 187
" park " 184

Six-horse teams are preferable to four-horse teams, such as are used in Spain. With this exception, there is nothing in the organization of the French 6th and 7th Engineer Regiments (pontoniers) worthy of imitating.

2. Mountain Bridging Train.

There is no mountain bridging train in France. The Commission believes that, with the exception of the Berthon equipment used by the English in India, which can be transported either in two-wheeled carts or on pack animals, the Pfund, employed in Argentina, which only admits of the passage of foot soldiers, and then only with great precautions, and the Very equipment described above, no army has attempted to resolve, nor even to sketch out, a solution of the problem.

Only in Spain, on the occasion of the war in Africa in 1859 and 1860, has the question of a bridging train to be carried on the backs of mules or camels been considered. The Terrer equipment, an application of the Birago trestle, was offered as a solution, and remains as the Spanish regulation mountain equipment, which rendered useful services during the last Civil War. The greater mobility required by armies at the present time has demonstrated its deficiencies, and the Regiment of Pontoniers (Spanish) has just finished the design of a more mobile equipment, in which the advances made by science in the last few years have been utilized.

ITALY.

Organization and Duties of the Corps of Engineers.

The Corps of Engineers consists of sappers and miners, telegraphists, railwaymen, pontoniers, train, and *lagunari*, and also deals with ballooning, visual signalling, electric lighting, and carrier pigeons. In addition, it is charged with the construction, improvement, maintenance, and administration of fortifications and military buildings. It is organized into two inspectorates, six commands, five regiments, one railway brigade, fifteen directorates for the service of the Territorial Army, and two separate directorates and offices for the service of the Royal Navy. It is also in charge of the workshops for the construction of engineer material.

The inspectorates are directly subordinate to the War Minister, and comprise the Consultative Committee and the committee dealing with Engineer troops and buildings.

The Chief Engineers have in relation to the troops a status analogous to that of Generals of Brigade. The Chief Engineer is directly subordinate to the General Commanding his army corps.

TECHNICAL SERVICES.

The technical administrative services of the Engineers embrace the construction, maintenance, and administration of military buildings of all kinds; the production of the mobile material necessary for the various services of the Engineer arm, including vehicles, and the production of various barrack stores.

The use to which each building is to be allotted is dictated by the Minister of War. In urgent cases the General Officer commanding a corps or division may temporarily alter the allotment of a building, provided that the matter is not of great importance, and that it is reported to the War Office.

For the construction and maintenance of buildings the directorate make use of the sums placed at their disposal by the War Office. The directorates keep up to date the plans and inventories of the property which they administer, and when necessary carry out new works and plans, issue information on which public tenders are based, and enter into contracts in conformity with the Regulations of 1881.

Mobile material is produced by the Engineer workshops at Pavia, where raw materials are purchased and all necessary articles manufactured. A few articles are bought in the open market.

The audit of the Engineer accounts is carried out by the audit office attached to the inspectorate of engineering construction.

The Engineer troops are distributed as follows:—

Engineer Regiments.		Companies.	
Regiment.	Station.	Technical.	Train.
1st (Pavia) ...	Sappers (Pavia, Rome, Mesina)	12	—
	Train	—	2
2nd (Casala) ...	Sappers (Casala and Bologna)	12	—
	Train	—	2
3rd (Florence) ...	Telegraphists (Florence, Verona, Placencia) ...	12	—
	Specialists, Balloons, etc. (Rome)	2	—
	Train	—	2
4th (Placencia)...	Pontoniers (Placencia, Verona, Rome)	8	—
	Lagunari (Venice)	2	—
	Train	—	3
5th (Turin) ...	Miners (Turin, Albenga)	12	—
	Train	—	1
	Railway (Turin)	6	—
	Total ...	66	10

Each regiment has a regimental staff and a depôt. The Railway Brigade has a brigade staff.

On mobilization, 58 companies of Engineers are formed from the mobile militia for various duties, four being train companies.

The *lagunari* are for water transport at Venice and on the lagoons.

WHEELED TRANSPORT.

(a). *Vanguard Bridging Trains.*

The subject has been very fully considered in Italian military periodicals. Reference should be made to Colonel Rocchi's article in the *Rivista di Artiglieria é Genio*, 1885, Vol. I., p. 67; *I ponti portatili ed il loro impiego in guerra*, by Mirandoli, Vol. IV., p. 461; *Le sezioni da ponte per zappatori addette alledivisioni de Bignami*, 1894, Vol. I., p. 438; *I ponti de avanguardia divisionali*, by Spaccamela, 1899, Vol. II., p. 49; *Studio di un ponte metallico di avanguardia*, by Guada, 1900, Vol. II., p. 382; and *Il ponte metallico di avanguardia*, by Capt. Maggiorotti, 1901, Vol. III., p. 222.

A satisfactory solution has, however, not been attained, but the duties are carried out by the bridging sections which are attached to Engineer regiments, and carry sufficient material for the construction of—

A pontoon bridge, 21 m. (23 yds.) long.
A trestle bridge, 34 m. 20 (38 yds.) long.
A bridge of three trestles and one pontoon, 34 m. 40 (38 yds.) long.
A bridge of two trestles and two pontoons, 34 m. 60 (38 yds.) long.

Exceptionally, and by using only five baulks to a bay, there can be constructed—

A bridge of four trestles and one pontoon, 41 m. 20 (45 yds.) long,
A bridge of three trestles and two pontoons, 41 m. 40 (45 yds.) long,

neither of which will take loaded vehicles.

If half-pontoons are used as points of support, footbridges can be constructed to carry infantry across streams with a slow current.

The bridging section may be divided into two halves, identical in composition and organization.

Detail of the Material of a Bridging Section.

Article.	Distribution in the Vehicles.			Weight of each Unit.	Total Number.
	Transport.	Pontoon.	Trestle.		
Vehicles.				kg.	
Pontoon wagons	—	1	—	730	4
Trestle ,, ...	—	—	1	760	2
Transport ,, (Model 1876)... ...	1	—	—	895	1
Supports.					
Transoms	—	—	2	118	4
Saddles	—	1	—	3·15	4
Short legs	—	—	4	15	8
Medium ,, ...	—	—	4	20	8
Long ,, 6 m. (20')	—	—	4	34	8
5 m. legs (16′ 6″)...	—	—	4	29	8
Half-pontoons	—	1	—	380	4
Suspension chains	—	—	4	11	8
Shoes (sets)	1	—	—	2·70	1

Detail of the Material of a Bridging Section.—Continued.

Article.	Distribution in the Vehicles.			Weight of each Unit.	Number.
	Transport.	Pontoon.	Trestle.		
Superstructure.					
Half-chesses	—	2	—	10·50	8
Chesses	—	29	14	15·25	144
Gunwale baulks	—	3	—	12	12
Saddles, with pins	—	—	2	40	4
„ without pins	—	—	2	35	4
Roadbearers	—	8	—	65	32
Rope.					
Anchor cables	—	1	—	35	4
Ropes for horses	1	—	1	2·70	3
Ropes	—	2	1	4·10	10
Baulk and wagon lashings	—	4	—	1·60	16
Rack lashings	—	15	5	0·515	70
Miscellaneous.					
Anchors	—	1	—	65	4
Anchorages	—	1	—	3·15	4
Boathooks	—	—	1	7	2
Pickets: small	—	—	4	5·66	8
Pickets: large	—	—	2	15·50	4
Pickets: medium	—	—	2	10·75	4
Pickets: for horses	2	—	—	3·87	2
Oars	—	14	—	6·66	56
Balers	—	1	—	0·65	4

The equipment also comprises entrenching tools, smiths' and carpenters' tools, lanterns, and materials for extemporized bridges.

Vehicles.

Pontoon wagon	Weight of wagon empty	730 kg.
	„ „ „ loaded ...	2140 „
	Height „ „ „	2·44 m.
	Length „ „ without pole ...	7·46 m.
	Width „ „ over all ...	3·50 m.
	Track of wheels	1·58 m.

This wagon carries half a pontoon with its equipment, 8 baulks, 26 chesses, 1 box, etc.

Trestle wagon	Weight of wagon empty	760 kg.
	„ „ „ loaded ...	1970 „
	Height „ „ „	1·82 m.
	Length „ „ without pole ...	6·65 m.
	Width „ „ over all ...	2·96 m.
	Track of wheels	1·58 m.

This wagon carries 2 transoms, 4 large, 4 medium, and 4 short legs, 14 chesses, 2 chock-baulks, and 2 baulks.

Ordinary transport wagon, model 1876.	Weight of wagon empty	893 kg.
	Length „ „ without pole ...	3·622 m.
	Width „ „ over all ...	1·905 m.
	Track of wheels	1·36 m.

This wagon carries articles of equipment and general service, provisions and forage, and also a few accessories for the wagons of the section.

DESCRIPTION OF THE PARTS OF THE BRIDGE.

This equipment is modelled on the Birago, and is a lighter form of that which will presently be described. It differs from the Austrian patterns in details of organization, in the form of the pontoons, in the method of fastening them together, in the transoms and saddles having pins fitting into holes in the baulks, which are not provided with claws.

Trestle.—Birago system, with legs of four different lengths, and wooden shoes.

Transom.—Length, 5·22 m.; depth, 0·23 m.; width at the ends 0·21 m., in the middle 0·16 m.

Legs. — Lengths 6 m., section 0·09 m. × 0·12 m.; 5 m., section 0·09 m. × 0·12 m.; 4 m., section 0·09 m. × 0·15 m.; 2·50 m., section 0·09 m. × 0·15 m.

Suspension Chains.—Length, 2 m.; diameter of the iron of the links, 0·015 m.

Pontoon.—Cavalli system. Wooden, trapezoidal, bi-partite. Length of pontoon 7·86 m., and of one section 4·38 m. Width across the gunwales, 1·91 m.; at the bottom, 1·42 m. Weight, 600 kg. Weight of anchor, 65 kg.

Baulk.—Length 7 m., section 0·11 m. × 0·15 m.

Chesses.—Length 3·27 m., section 0·04 m. × 0·29 m.

Loads of the Vehicles.

Pontoon wagon	Chesses	26	Trestle wagon	Legs, 2·50 m. ...	4
	Baulks	8		Pickets	8
	Sections of pontoon	1		Shoes	4
	Saddle	1		Suspension chains	4
				Legs, 4 m. ...	4
Inside pontoon	Chesses	3		„ 5 m. ...	4
	Medium chesses ...	2		„ 6 m. ...	4
	Anchor cables ...	1		Boathooks ...	1
	Oars	3		Baulks	4
	Anchor	1		Transoms ...	2
	Box of tools and caulkers' tools, etc.	1		Chesses	14
				Rope, etc. ...	—

ARMY AND ARMY CORPS BRIDGING TRAINS.

As already stated, the 4th Engineer Regiment is organized for the bridging services of the Army. It is composed of—

Regimental staff, 3 brigades of pontoniers (8 companies), 1 brigade of *lagunari* (2 companies), 3 companies of train, and 1 depôt company, with an effective total of 59 officers and 1,534 pontoniers.

On mobilization the companies become independent and have an establishment of 5 officers and 240 pontoniers each, except the *lagunari*, which have 5 officers and 340 pontoniers each.

The distribution of the bridging trains, according to circumstances, is determined by higher authority. In general the army corps are not provided with bridging trains, the divisions having each only one bridging section, as already described.

The equipment consists of 46 wagons, viz.:—22 pontoon and baulk wagons, 5 pontoon and chess wagons, 3 trestle wagons, 10 chess wagons, 1 boat wagon, 3 transport wagons, 1 park wagon, and 1 field forge. Each set of equipment contains material for the construction of 196 m. (217 yds.) of pontoon bridge, and 28 m. (31 yds.) trestle bridge, *i.e.*, for 216 m. (240 yds.) of mixed bridge.

The transport is effected by a section of the train, and the bridging duties are performed by one company of pontoniers.

The total quantity of bridging material is 3,000 m. (nearly two miles).

The system is founded on the principles of Cavalli, and is analogous to that of the bridging sections already described, the dimensions of the parts and the organization being varied.

The pontoon is of the Cavalli type, and the trestle of the Birago type.

The baulks are without claws, and are provided with holes into which the pins on the transoms and saddles fit.

The chesses are fixed by baulks racked down to them.

The following is a list of the principal parts of the equipment :—

Composition of a Bridging Train.

Article.	Total Number in the Train.	Distribution of Articles to the Wagons.									Average Weight in Kilos.
		Pontoon and Baulks.	Pontoon and Chesses.	Chesses.		Trestle.	Boat.	Park.	Transport.	Field Forge.	
				8 First.	9th & 10th.						
Number of wagons	46	22	5	8	2	3	1	1	3	1	
Wagons.											
Transport wagons	3	—	—	—	—	—	—	—	1	—	912
Park wagons, covered ...	1	—	—	—	—	—	—	1	—	—	925
Pontoon and baulk wagons, model 1860	22	1	—	—	—	—	—	—	—	—	720
Pontoon and chess wagons, model 1860	5	—	1	—	—	—	—	—	—	—	759
Trestle or chess wagons ...	13	—	—	1	1	1	—	—	—	—	724
Field forge wagon	1	—	—	—	—	—	—	—	—	1	1184
Supports.											
Transoms, model 1860 ...	9	—	—	—	—	3	—	—	—	—	110
Pontoons, model 1860 ...	27	1	1	—	—	—	—	—	—	—	540
Boats	2	—	—	—	—	—	2	—	—	—	300
Suspension chains	18	—	—	—	—	6	—	—	—	—	11
Anchorages	27	1	1	—	—	—	—	—	—	—	3·15
Trestle legs, short	18	—	—	—	—	6	—	—	—	—	15
Trestle legs, medium	9	—	—	—	—	3	—	—	—	—	27
Trestle legs, long	6	—	—	—	—	2	—	—	—	—	40
Shoes	18	—	—	—	—	6	—	—	—	—	8
Baulks	149	5	5	—	—	—	—	—	—	—	8·80
Cut baulks	54	2	2	—	—	—	—	—	—	—	3·50
Saddles, with pins	9	—	—	—	—	3	—	—	—	—	35
Saddles, without pins ...	9	—	—	—	—	3	—	—	—	—	31
Superstructure.											
Half-chesses	54	2	2	—	—	—	—	—	—	—	6·50
Chesses...	709	3	25	50	50	6	—	—	—	—	23·50
Baulks	220	10	—	—	—	—	—	—	—	—	55
Lashings without rack sticks...	346	8	8	—	2	4	14	100	—	—	0·535
,, with ,, ,, ...	408	8	8	—	—	64	—	—	—	—	0·66
Lashings	54	2	2	—	—	—	—	—	—	—	1·06
Wedges	108	4	4	—	—	—	—	—	—	—	1·33
Rope.											
Anchor cables, model 1860 ..	33	1	1	—	—	—	—	6	—	—	41
Large anchor cables for the P.O.	2	—	—	—	—	—	—	2	—	—	74
Ropes	72	2	2	1	1	—	—	8	—	—	4·70
Lashings	112	4	4	—	—	—	—	4	—	—	1·60
Cables	4	—	—	—	—	—	—	4	—	—	50
,, for boat grapnels ...	2	—	—	—	—	—	2	—	—	—	7·50
Rope	1	—	—	—	—	—	1	—	—	—	2·00
Horse ropes	18	—	—	1	1	1	—	1	1	1	3·50
Spun yarn	59 kg.	—	—	—	—	—	12 kg.	45 kg.	—	2 kg.	—
Miscellaneous.											
Anchors, model 1860... ..	29	1	1	—	1	—	—	—	—	—	65
Grapnels	2	—	—	—	—	—	2	—	—	—	22
Balers	35	1	1	—	-	2	2	—	—	—	0·65
Boathooks	16	1	1	—	—	—	2	—	—	—	7
Wells' lights	1	—	—	—	—	—	—	—	—	1	123
Pickets, short	18	—	—	—	—	6	—	—	—	—	5·66
Pickets, long	9	—	—	—	—	3	—	—	—	—	15·55
Pickets, medium	29	—	—	—	2	9	2	—	—	—	10·75
Pickets for horses	40	—	—	2	—	2	—	6	2	2	3·87
Oars	158	5	5	—	—	—	10	—	—	—	8·30
Spars	54	2	2	—	—	—	—	—	—	—	2·20

Also tools of various kinds, lanterns, and materials for extemporized bridges.

DESCRIPTION OF THE DIFFERENT PARTS OF THE BRIDGE.

Pontoon (*Fig. b*).—Of wood, Cavalli type, with stern square, so as to enable two to be joined together in heavy bridge and rafts. Length, 7·50 m. Width at the gunwales, 1·76 m.; at the bottom, 1·32 m. Depth at the bow, 1·10 m.; at the stern, 0·80 m.; where the bow commences to curve, 0·90 m. Cubic capacity, 10·300 cubic mètres. Weight, 540 kg. Buoyancy, 9,400 kg.

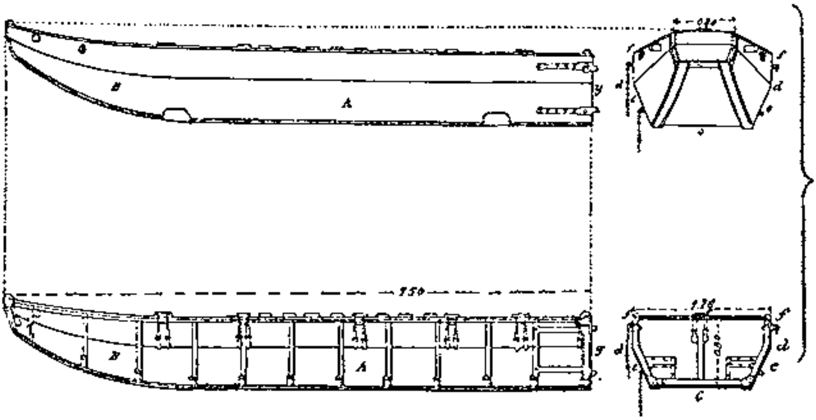


FIG. *b*.

Trestle.—Birago system, analogous to that described for the bridging sections. The transom is provided with pins fitting into holes in the baulks, of which there are six to a bay.

Transom.—Length, 5·22 m. Width at the ends, 0·21 m.; at the centre, 0·16 m. Depth, 0·23 m. Weight, 110 kg. Distance between the points of suspension, 3·40 m.

Legs.—Lengths, 5 m., 4 m., and 2·50 m. Section, 0·09 m. × 0·15 m. Weight, 42·50, 26, and 15 kg. respectively.

Suspension Chains.—Length, 2 m. Diameter of the iron, 0·013 m. Weight, 11 kg.

Shoes.—Length, 0·69 m. Width in the middle, 0·28 m. Thickness, 0·075 m. Of oak.

Saddle.—Placed longitudinally in the pontoon to support and fix the baulks. Length, 4 m. Section, 0·11 m. × 0·15 m. Weight, with pins, 35 kg.; without pins, 31 kg.

Pickets.—Of ash, iron bound. Length, 1·76 m., 1·40 m., and 1 m. Weight, 15·55, 10·75, and 5·66 kilos. respectively.

Baulks.—Without claws, and with holes into which fit the pins of the transoms and saddles. Length, 7 m. Section, 0·11 m. × 0·15 m. Weight, 60 kg. Distance of the holes from the ends, 0·10 m., 0·89 m., and 1·10 m. Length in the clear of the bays—Pontoons, 5 m.; trestles, 6·64 m.

Chesses.—Length, 3·30 m.; breadth, 0·33 m.; thickness, 0·05 m.; weight, 23·50 kg.

Half-Chesses.—Length, 3·50 m.; breadth, 0·12 m.; thickness, 0·05 m.; weight, 6·50 kg.

Rack Lashing.—Length of rack stick, 0·70 m.; of lashing, 1 m.

Anchor.—Cast iron, of the ordinary shape; weight, 65 kg.

Oars.—Length, 4·09 m.; weight, 8·60 kg.

Boathooks.—Length, 4 m.; weight, 7 kg.

Boats.—Length, 7·75 m.; width across gunwales 1·80 m., across bottom 1·37 m.; depth at the bow 0·64 m., at the stern 0·56 m., amidships 0·41 m.; cubic capacity, 3·200 cubic mètres; buoyancy, 2,920 kg.

Grapnels.—Weight, 21 kg.

Ropes.—Anchor cable, 80·90 m. long; 0·025 m. in diameter; weight, 41 kg.

Warps.—15 m. long; 0·02 m. in diameter; weight, 4·70 kg.

Lashings.—4·75 m. long; 0·02 m. in diameter; weight, 1·60 kg.

Handrail Rope.—160 m. long; 0·02 m. in diameter; weight, 50·50 kg.

Large Anchor Cable.—100 m. long; 0·03 m. in diameter; weight, 74 kg.

Grapnel Cable.—50 m. long; 0·13 m. in diameter; weight, 7·50 kg.

Handrail Stanchions.—Of tubular iron; exterior diameter, 0·022 m.; weight, 2·20 kg.

VEHICLES.

Wagons.	Length without Pole.		Height.		Track.	Distance between the Axles.	Average Weight.		
	Empty.	Loaded.	Empty.	Loaded.			Empty.	Loaded.	
	m.	m.	m.	m.	m.	m.	k.g.	k.g.	
Pontoon and baulk (*Fig. c*)	5·75	7·80	1·41	2·52	1·50	3·50	720	2250	With pontoon.
Ditto (*Fig. d*)	5·75	7·80	1·41	2·52	1·50	3·50	720	1860	With two boats.
Pontoon and chess ...	5·75	7·50	1·48	2·59	1·50	3·50	760	2280	
Trestle or chess	4·20	5·40	1·53	2·19	1·50	2·44	725	2270	With trestles.
Ditto	4·20	4·20	1·53	1·96	1·50	2·44	725	2105	With chesses only.
Park, covered	3·52	3·52	2·25	2·25	1·50	1·92	925	2240	
Field forge ..	4·70	4·70	2·21	2·21	1·50	2·45	1123	2280	
	3·96	3·96	1·79	2·21	1·50	1·92	990	1700	

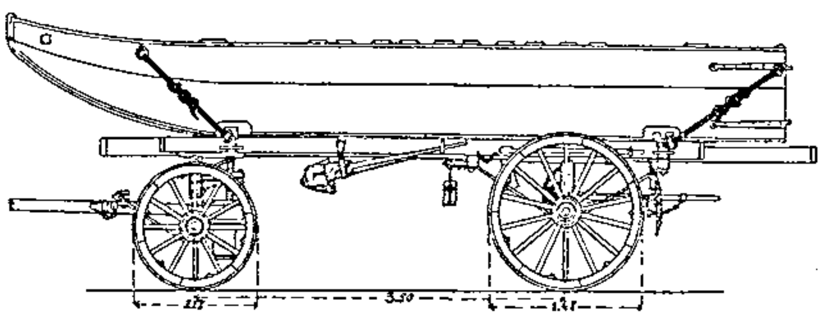


FIG. *c*.

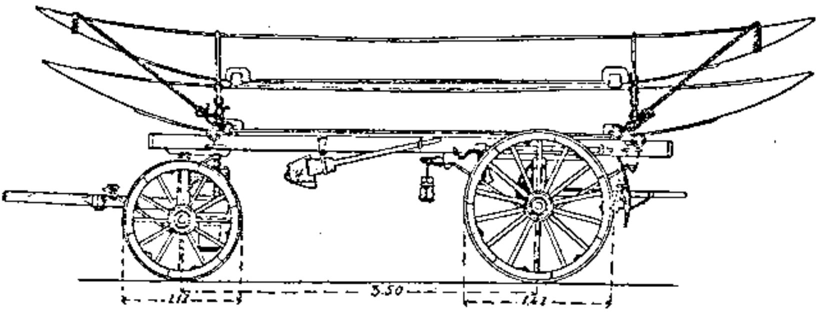


FIG. *d*.

Loads of the Vehicles.

Pontoon and baulk wagon

Baulks	10
Pontoon	1
Lashings	4
Chesses	3
Handrail stanchions	2
Half-chesses ...	2
Moorings... ...	1
Anchors	1
Anchor cables ...	1
Oars ...	5 or 6
Boathooks ...	1
Baulks ...	5 or 6
Cut baulks ...	2
Rack lashings ...	8
Balers	1
Warps	2
Boxes containing various articles.	

Boat wagon

Boats ...	2	
Lashings ...	4	One set packed in each boat.
Oars ...	5	
Boathooks ...	1	
Grapnels ...	1	
Balers ...	1	
Grapnel cables	1	
Medium pickets	2	
Ropes ...	1	
Rack lashings	6	
Lifebuoys ...	1	
Tools, lead lines, etc.		

Pontoon and chess wagon

Chesses ...	22
Pontoon ...	1
Lashings ...	4
Empty box ...	1

Inside the pontoon, carried on a pontoon and chess wagon, are packed:—

Chesses	3	Baulks...	5 or 6
Handrail stanchions	2	Cut baulks	2
Half-chesses	2	Rack lashings	8
Moorings	1	Balers	1
Anchors	1	Warps...	2
Anchor cables	1	Besides, in boxes, lashings, wedges, etc., etc.	
Oars	5 or 6		
Boathooks	1		

Wagon	Contents	Number
Chess wagon	Chesses	50
	Warps	1
	Anchors	1
	Lashings	2
	Also, in a box, entrenching tools and materials for extemporized bridges.	
Field forge wagon	Field forge, smiths' and farriers' tools.	
	Horseshoes, iron, etc.	
	Wuelle lamp (Wells').	
Trestle wagon	Saddles with pins	3
	Legs, long ...	2
	Saddles without pins	3
	Lashings ...	3
	Transoms ...	3
	Legs, medium ...	3
	Chesses	6
	Shoes	6
	Legs, short ...	6
	Pickets, large ...	3
	Pickets, medium	9
	Pickets, short ...	6
Trestle wagon (*cont.*)	Suspension chains	6
	Rack lashings ...	64
	Wedges ..	4
	Lashings ...	1
	Also, in a box, entrenching tools and materials for extemporized bridges.	
Park wagon	Various articles, rope, explosives, various kinds of tools.	
Transport wagon	Stationery.	
	Safe.	
	Kitchen for six persons, supplies for officers, clothing and equipment, tents, tailors' and shoemakers' boxes, horse ropes and pickets, spare wheels and poles, etc.	

TRACTIVE FORCE.

Applying the same principles as in the case of the French bridging train, and assuming the weight of the loaded park wagon (2,240 kg.) as the mean of all the wagons, that six-horse teams are used, that the wagon has no springs, and that the mean diameter of the wheels is 1·25 m., we obtain a coefficient of traction equal to 214.

COMPARISON OF THE FRENCH, ITALIAN, AND SPANISH BRIDGING TRAINS.

The Commission considers that the Spanish bridging material is in every way superior to the French and Italian, and that it is only in quantity of material that France and Italy have the advantage over Spain.

France	possesses	4,830	mètres of bridge.
Italy	„	3,000	„ „ „
Spain	„	882	„ „ „

Experience has shown that an army should be provided with 8 mètres of bridge for every 1,000 men. Otherwise, extemporized bridges must be resorted to, and the time required for their construction cannot usually be spared.

The Spanish bridging material is modern, and possesses many advantages, viz. :—(1). The latest advances in metallurgy have been utilized, sheets of galvanized steel, 1·13 mm. in thickness being used, and nearly all the metal work of the equipment is of this material. (2). A single steel pontoon, besides being lighter for its dimensions and having a greater buoyancy than a wooden pontoon, costs much less for maintenance. (3). Repairs, made in the cold, can be much more rapidly and safely effected. (4). The symmetrical shape of the pontoon makes it extraordinarily easy to manœuvre, both when in bridge and when used as a boat. (5). The trestle is a marked improvement on the Birago trestle; the ends of the transom being of steel, sliding up and down the legs is facilitated. The inclination of the legs has been reduced to the slope strictly necessary for securing lateral stability. (6). Only one type of wagon is used. (7). Almost all the elements are interchangeable. (8). The coefficient of traction, which is 187 in France and 214 in Italy, is only 162 in Spain with four-horse teams. (9). Great simplicity (10). The speed at which a bridge can be constructed with the Spanish equipment is much greater than it is in the case of the French and Italian materials.

In both France and Italy it is possible to practice bridging in rivers 200 m. or more in width, and with currents of 4½ miles an hour and upwards. This cannot be done in Spain, as it is only during the spring, the season in which the recruits are being trained, that such rivers can be found in that country.

The Commission concludes its report by saying: "The contempt with which the great military powers treat everything that refers to Spain, alone explains the superiority which we hold over almost all of them in the matter of bridging material."

'M.'

REVIEW.

MILITARY HYGIENE.

By Lieut.-Colonel R. H. Firth, R.A.M.C.—(J. & A. Churchill, London. 3s. 6d. nett).

In the 300 pages of this book, Lieut.-Colonel Firth has condensed a mass of information which everyone should know, but which unfortunately everyone does not. Unfortunately, because it is well known that in a campaign the losses through preventable diseases far exceed the losses due to actual fighting, and the author clearly shows that success in war depends not only in having an efficient army, but in keeping it effective. How this can be done by taking the necessary precautions—generally of a simple character—is the purport of this work, and no officer, N.C.O., or man can be said to really understand his business till he has assimilated its contents.

By an Army Order at the beginning of the year, it has been rendered compulsory for every officer to pass an examination in this subject for promotion; but this is not a matter to be crammed up to pass a certain test. It is vital to the efficiency of the Army, and every officer should be acquainted with the details with which the book deals.

Lieut.-Colonel Firth, who was for some years Professor of Military Hygiene in the Royal Army Medical College, and is now officer in charge of the School of Army Sanitation, treats the subject from the points of view of the barracks, the camp, in the field, and on the march, and one is struck with the thoroughness with which the subject is discussed, and surprised that so much has been introduced into such a comparatively small compass. As a Corps we are specially concerned with much with which this book deals, and therefore both as soldiers and technical officers we should be doubly interested in the subject.

The author is to be congratulated on the success which has attended his efforts to make things extremely clear, and the perusal of the treatise impresses one with its importance.

The illustrations are simple, the printing good, and the paper excellent, and altogether this small work will prove a valuable addition to every officer's bookshelf.

J. Winn.

NOTICES OF MAGAZINES.

JOURNAL DES SCIENCES MILITAIRES.

September 15th, 1908.

The article, on "Dirigible Balloons" is continued, the present number dealing with the possibility of their destruction by rifle and artillery fire. Infantry fire is considered to be practically harmless on account of the impossibility of setting the sights correctly, except by chance, and also on account of the very small hole made in the envelope when hit. "Experience proves that the loss of gas from a hole made by a rifle bullet, diminishes the lifting power by 7 or 8 kilogrammes at the outside The only serious damage that can be effected is by a lucky shot hitting either an aeronaut or the motor."

Shrapnel—by reason of its depth—is considered to be the artillery projectile for use against balloons. The balloon will be sheltered when 100 mètres above the highest point of the trajectory of any shrapnel. On the whole, a minimum height of 600 or 700 mètres is enough for protection from field guns. By burying the trail, a height of about 950 mètres might be attained as the highest point of the trajectory, but the mobility and rapidity of fire is reduced in consequence, and there is also a chance of the gun turning a somersault. With light howitzers of the German type, a balloon moving at 30 miles an hour, if at a height of 1,000 mètres, would be under fire for five minutes, and for 2½ minutes if 1,500 mètres up. Mountain artillery is not so dangerous as howitzers, but more so than field guns. Machine guns may be a serious danger, provided the range is known. Heavy artillery, including naval anti-torpedo-boat guns, is more dangerous than field guns. A balloon could not safely approach a ship by day except at a very great height. Range-finding is too slow, as modern methods of ranging shots are accurate enough to find a sufficiently close range. The method of fire must be salvoes of shrapnel.

An account of Austrian, Belgian, and French experiments to determine the vulnerability of captive balloons is given, and the lack of success of Japanese and Russians in bringing down balloons, is mentioned.

The conclusion arrived at is that an armoured automobile, carrying a quick-firing gun capable of 70 degrees elevation, is the best means of engaging dirigibles, and there is a description of an Austrian gun of this type.

The first of a series of articles on "Infantry Machine Guns" contains a description of the early types and their use, particularly in 1870. After the American Civil War glowing reports of the destructive qualities of machine guns were published by American papers, apparently with a view to getting rid of their surplus stock. The French, somewhat taken in by this, secretly built some of their own design as a surprise on the outbreak of war. They were very heavy, needing teams of four horses, and were always breaking down owing to the gun crews being unused to them. In action they were found to be quite unable to cope with artillery fire, but when protected from it, did good service more than once in defending posts against infantry. Their moral effect was very great. The Bavarians had one battery, which only arrived towards the end of the war, and was of great use at Coulmiers. In consequence of their experience both countries decided against using machine guns in the field.

Gatling guns were used by the Russians at Plevna, by the Chilians in Peru, and in our Egyptian Campaign. They were used essentially on the defensive, and had great effect especially on undisciplined troops.

One of a series of articles on the Russo-Japanese War appears in this number, the particular subject being machine guns. Though neither side had many of these guns on the outbreak of war, both largely increased their stock. The Japanese had 200 and the Russians 23 eight-gun companies at the end of the war. The Japanese guns at the end of the war were attached to regiments in groups of two to six. At the Yalu the eight Russian machine-guns checked at first the turning movement of the Japanese right, silenced a battery, and helped to secure the retreat.

An account of a Russian company's experience at Liao-Yang is given from the *Invalide Russe*. The company checked the enemy's advance, and held its position for two days, finally retreating after suffering heavy loss from artillery fire. It was impossible to reply to this owing to the range. At Mukden two machine-guns, attached to the section occupied by the 164th Regiment, prevented the Japanese from reaching the village occupied by this corps, and according to Capt. Niessel, all accounts agree as to their great moral and material value. Although especially suitable for the defensive, they can be very useful on the offensive, as they can render support to the infantry by approaching nearer than is possible for the more vulnerable artillery. They are very useful for pursuit or repulsing counter-attacks. Attached to cavalry, they give it an offensive power previously unknown, and cyclist companies are much strengthened by them.

The criticism on the Franco-German War is on the events from August 7th—12th.

The "Campaign in Styria" gives an account of the operations of Broussier's division about Gratz from June 21st to June 25th.

H. L. WOODHOUSE.

JOURNAL OF THE MILITARY SERVICE INSTITUTION (U.S.A.).

September—October, 1908.

This number contains no article of which one can say "Here is something really good and new, let me call attention to it"; but many of its pages are noticeable because they contain passages which with very little alteration might have been written for ourselves. This is specially remarkable in Major Foote's honourably mentioned essay on "The Military Necessities of the United States," as, for instance:—

"The military history of the United States, from the earliest settlement of the colonies down to within the past ten years, has been marked by a lack of adequate preparation for even a defensive war. Over 300 years' war with the Indians, resulting in the conquest of the vast territory comprised within our present boundaries, was replete with massacres, defeats, and failures, due to insufficient preparation. . . . But whether successful or not at the outset, the tenacity of our people has enabled them to triumph in the end over all foes, domestic or foreign. So that we look complacently upon the future, believing that, whatever comes, we are sure to succeed eventually, even though we may suffer defeat and humiliation in the beginning." The essay generally is a plea for thorough preparation in time of peace, and the author thinks he can detect a change in public opinion since the Spanish War, which is leading to "a more adequate recognition of our military necessities and a more efficient preparation for national defense."

The author's peroration to his appeal for improved coast defence is suggestive to those who care about the balance of power in the Pacific:— "We cannot rest easy until the Pacific Coast defenses of both mainland and inlands are completed and supplied, the Pacific fleet strengthened, and the Panama Canal opened." On p. 177 there occurs a passage which might have been written for England, but, unfortunately, we enjoy no "isolation" geographically:—"Our traditional reliance in war is upon volunteers, and owing to our isolation from other great nations, our people vaguely rely upon raising and setting on foot a sufficient number of Volunteers before any power would have time to land a large army on our soil. This idea, vague though it may be, amounts to a settled condition, and there is no use in running counter to it or trying to get around it. The people rule, and we must bow to their will." It will doubtless surprise many to learn that the United States, of all countries, foresee the possibility of invasion from over the seas, and are taking steps to guard against it.

Here is another sentence that ought to set us thinking, with reference not only to our home-defence forces, but also to our native Indian Army:— "No matter how enthusiastic and patriotic a people may be at the beginning of a war, there sooner or later comes a time in a protracted war when volunteering practically ceases." This might almost have been written with reference to our experiences at the time of the Boer War, and the following remark gives an American appreciation of conscription. Senator McDougall in 1862 said:—"Now, in regard to this conscription question, I will say, for myself, that I regretted much, when this war was first organized, that the conscription rule did not obtain. . . . I found some districts where some bold leaders brought out all the young men and sent them, or led them, to the field; in other districts—and they were the most numerous—the people made no movement toward the maintenance of the war; . . . The whole business has been unequal and wrong from the first. The rule of conscription should have been the rule to bring out men of all classes and make it equal throughout the country." In connection with this subject also it is instructive to read that "The conscription laws of the Civil War, passed in time of war, met with fierce criticism and objection, and their enforcement in some places was accompanied by violence and bloodshed," and many will agree with Major Foote when he says how necessary it is "to make familiar to all of us the nature, extent, and method of imposition of an obligation which may require a man to suddenly leave his business, sever home ties, and risk life itself." Among the author's more detailed recommendations may be mentioned his scheme for officering a large levy of volunteers by drafts from the active list of the Regular Army; senior captains and junior majors to become Volunteer colonels, other officers of field rank to become Volunteer brigadiers, etc. He lays great stress on the necessity of having well-trained officers, and recommends that Volunteer regimental officers should have special instruction in camp for 10 days annually. Their camp life is to be so like "the real thing" that "it is thought best for the Government to furnish rations for the officers, with the idea of familiarizing them with it, they to live on the ration in camp and superintend the seeking of it, or, if they choose, seeking it themselves." The discomfort (to put it mildly) of a sudden drop from three, or more, meat meals a day to rations pure and simple is a very real one in the case of all amateur soldiers and also of many Regular officers, as they would soon realize if the same practise obtained in this country.

Two other papers in this number touch on matters concerning the officer. In "Readjustment of Rank" Colonel C. J. Crane champions the regimental as opposed to the general-list system of promotion. Apparently the crack regiments are suffering from a block at present which would be relieved by a modification of the regimental system. The author, who has received quick promotion in a black regiment, protests.

Capt. C. D. Rhodes supplies a study of "How Best to Instruct Officers of our Army in Tactics," which has been read at the Army Staff College (U.S.A.), and is now published "as treating of a subject of vital interest and importance to the Army." His chief recommendations consist in the institution of well-equipped military libraries at all stations, and constant exercise in tactical problems both on the map (including war games) and on the ground (including manœuvres); so it cannot be said that he suggests anything very new to us. The following, in connection with instruction, not examination, reads oddly:—"The consensus of opinion is held that map-problems . . . should be marked, not on a numerical scale, but simply as 'excellent,' 'good,' 'poor,' 'unsatisfactory,' or the like." This points to a school-masterly frame of mind among the military instructors of the U.S. Army, which happily is very rare in our service; but it is only fair to Capt. Rhodes to acknowledge that he does consider it imperative that faults and preferable dispositions should be indicated in some manner. Two sentences are worth quoting. They follow the expression of a pious hope that American soldiers may display a "more certain degree of tactical skill and intelligence" than their predecessors, and are as follows:—

"At any rate, we may hope not to stumble through our future wars in that hit-or-miss fashion which has characterized the past, trusting in the grace of God and the proverbial luck of the United States.

"And hand in hand with our tactical development we must strive to educate the American public to a realization of our military unpreparedness and tactical shortcomings, considering in its entirety that *greater* American army upon which we must depend in time of war."

The concluding portion of an essay on "Small Arms Ammunition Supply" is the only other article of more than local interest in this number.

T.F.

REVUE DU GÉNIE MILITAIRE.

August, 1908.

CALCULATIONS FOR STRAIGHT BEAMS.—A method of finding the stresses in a loaded beam. The following are some of the results arrived at:—

Let AB be a beam of length a supported at A and B, the end at A being fixed. If the beam is uniformly loaded with w pounds per foot, the reaction at A will be $\frac{5}{8}wa$, and at B $\frac{3}{8}wa$. The bending moment at A will be $\frac{wa^2}{8}$. If both ends are fixed, the reactions will of course be equal, and the bending moment at either end will be $\frac{wa^2}{12}$.

Again, let AB be a beam resting freely on three supports at A, B, and C, and let the lengths of AB and BC be a and b respectively. Then the reaction at A will be $\frac{3a^2+ab-b^2}{8a}w$, at B $\frac{(a+b)(a^2+3ab+b^2)}{8ab}w$, and at C $\frac{3b^2+ab-a^2}{8b}w$.

If the beam is fixed at A and C, the reaction at A is $\frac{4a^2 + ab - b^2}{8a}w$, at B $\frac{(a+b)^3}{8ab}w$, and at C $\frac{4b^2 + ab - a^2}{8b}w$. The bending moment at A is $\frac{2a^2 + ab - b^2}{24}w$, and at B $\frac{2b^2 + ab - a^2}{24}w$.

The reactions and bending moments are also calculated for beams resting on four, five, and six supports. As the number of supports is increased, the reaction at each intermediate support approximates to the total weight on one span.

THE FOREIGN MILITARY ESTABLISHMENTS IN CHINA.—A continuation of the previous articles. The writer considers that all the Japanese arrangements indicate their intention of making a long stay in the country. A short description is given of the various Italian barracks, but these call for no special mention.

J. E. E. CRASTER.

CORRESPONDENCE.

VERTICAL SUNDIALS.

SIR,

In the August number of the *R.E. Journal* Lieut. Dunman gives the ordinary method of computing the hour-lines of a horizontal sundial. The formula may, for convenience, be written

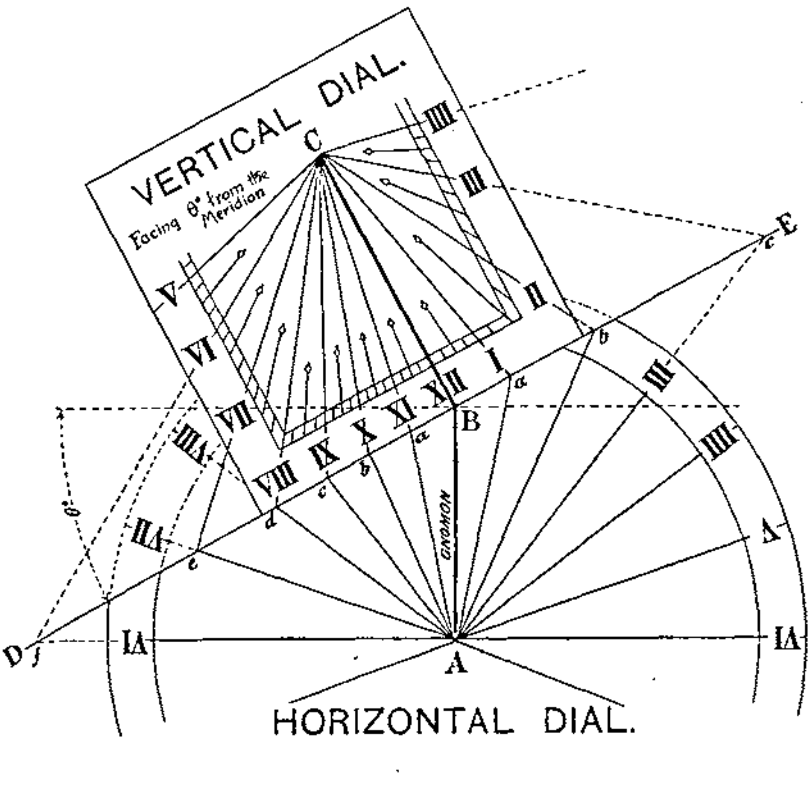
$$\tan X = \sin \text{latitude} \times \tan (H \times 15) \qquad \text{(i.)}$$

where H is the number of hours after or before noon, and where X is the angle with the meridian made by the shadow of the Gnomon at H hours.

For a vertical dial facing due South in Northern Latitudes, or due North in Southern Latitudes, the formula becomes

$$\tan Y = \cos \text{latitude} \times \tan (H \times 15) \qquad \text{(ii.)}$$

where Y is the angle with the vertical.



But in practice it is often desired to fix a vertical sundial to a wall which does not face exactly South (or North in Southern Latitudes), and, as I have been unable to find information in any text-book as the method of arriving at the hour-lines in such a case, I venture to hope that the method described below may be of service.

First draw a horizontal dial, the hour-lines being calculated from formula (i.), and in the drawing let AB be a plan of the Gnomon (taking any convenient length).

Suppose the aspect of the proposed vertical dial to be θ° East of South; then through B draw DBE, making an angle $90^\circ - \theta$ with the meridian and cutting the horizontal hour-lines in a, b, c, d, etc.

Set up BC at right angles to DE, making BC : AB = tan latitude. Join C with a, b, c, d, etc.

Then Ca, Cb, Cc, Cd, etc., are the required hour-lines of the vertical dial.

The correctness of this method will at once be apparent if the drawing be folded along the line DE until the vertical dial is in a vertical position for, since by construction BC : AB = tan latitude, the folded paper represents a combined horizontal and vertical dial, having the Gnomon ABC common to both faces; and the shadow lines must take the direction AaC, AbC, AcC, AdC, etc.

For those who prefer to compute the angles mathematically, the formula for a vertical dial facing θ° from the meridian is

$$\tan Y = \frac{\sin X}{\tan \text{latitude} \times \sin (90^\circ - X + \theta)} \quad \text{(iii.)}$$

where X has the same value as in (i.).

In all vertical dials the plane of the Gnomon must of course correspond with the meridian, and the sloping edge must, as in the case of horizontal dials, make an angle φ with the horizontal plane, where φ is the latitude of the place.

J. B. MACGEORGE,
Capt., R.E.

The Editor, *R.E. Journal.*