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Secretary: Lieut.-Col. P. H. Kealy, 1st October, 1927.

2,150—1-9-28.

The Institution of Royal Engineers

to the

Institution of Civil Engineers

We, the President and Members of the Institution of Royal Engineers, offer to the President and Members of the Institution of Civil Engineers our hearty congratulations on the completion of the first one hundred years of your activities since the grant of the Charter to your Institution.

Your Institution was the first corporate body formed for the purpose, in the words of your founders, of "facilitating the acquirement of knowledge necessary in the civil engineering profession and for promoting mechanical philosophy." How well the objects of your founders have been carried out, the great progress in engineering science during the past century and the flourishing condition of your great Institution bear witness.

When you adopted your title of Civil Engineers, a distinction was drawn between the "Civil" and "Military" branches of Engineering. As representing the military branch, the Institution of Royal Engineers cannot but recall, on such an occasion as this, the close co-operation which existed during the late war between all members of the Engineering profession.

In peace time, the Military Engineer must always be watching and aiding the progress of Engineering, so that advantage may be taken of inventions and ideas that may assist the nation in times of war, and he is therefore ever anxious to make use of the experience gained by your members in the very wide field in engineering science and practice covered by them. In a national effort in war your members will become Military Engineers in ever-increasing numbers, bringing the weight of their experience to bear for the common good.

The Institution of Royal Engineers therefore welcomes this opportunity of taking part in the celebration of the centenary of the Institution of Civil Engineers, with the earnest hope that the prosperity and usefulness of your Institution may continue to flourish, and that the cordial relations that have subsisted in the past between the two bodies of Engineers which we represent may continue in an increasing degree whatever the future may hold for us.

Signed on behalf of the Institution of Royal Engineers.

President.

Secretary.

Signed the 5th Day of June 1928

MEMORIAL TO LORD KITCHENER IN ALL SAINTS' CATHEDRAL, KHARTOUM.

Memorial to Kitchener

PRESENTATION OF AN ADDRESS TO THE INSTITUTION OF CIVIL ENGINEERS.

THE frontispiece shows the address presented by the Institution of Royal Engineers to the Institution of Civil Engineers, on the occasion of the Centenary Celebrations of the grant of their Royal Charter. The address was presented by Major-General P. G. Grant, C.B., C.M.G., President of the Institution of Royal Engineers, who attended the Celebrations as the delegate representing the Institution of Royal Engineers. It is printed in black and red on vellum, and enclosed in a suitable case.

MEMORIAL TO LORD KITCHENER.

THE accompanying photograph of the Memorial to Lord Kitchener, in All Saints' Cathedral, Khartoum, has been kindly sent by Major-General H. J. Huddleston, C.B., C.M.G., D.S.O., M.C., G.O.C. the Sudan, together with the following description :—

The memorial is the work of Lady Helena Gleichen, and depicts the recumbent figure of Lord Kitchener being borne as for burial on the shoulders of representatives of the armies of Great Britain, India and the Sudan, whom he commanded in his various campaigns.

The group is in bronze, mounted on a marble plinth, and has an over-all height of 4 ft. 11 in.

Round the edge of the bier, and repeated again in large letters round the centre of the marble plinth, is the following inscription :— " The unresting giant, who above war's din held his grave course and laboured mightily, now beyond toil and clamour sleeps within the bosom of the eternal sea."

Round the bottom of the base is another inscription, which reads : " Earl Kitchener of Khartoum, K.G., K.P., O.M., G.C.B., G.C.S.I., G.C.I.E., Gov. R. Sea Litt., Sirdar E.A., C.-in-C. Exp. Khartoum, South Africa, India, A and C. Gen. Egypt, S. of S. for War."

The memorial, which stands in the south transept, where also are the windows erected in memory of Sir Lee Stack, was given by the Sudan Government to the Cathedral.

It was dedicated by the Right Rev. Bishop Llewellyn H. Gwynne, D.D., LL.D., C.M.G., C.B.E., Bishop of Egypt and the Sudan, and was unveiled by His Excellency the Governor-General, Sir John L. Maffey, K.C.V.O., C.S.I., C.I.E., on 5th February, 1928.

Authors alone are responsible for the statements made and the opinions expressed in their papers.

THE RÔLE AND REQUIREMENTS OF AN ARMY CO-OPERATION SQUADRON.

A Lecture delivered by WING-COMMANDER O. T. BOYD, O.B.E., M.C., A.F.C., R.A.F., *at the S.M.E., Chatham, on March 1st,* 1928.

I HAVE been told to talk to you about the *rôle* and requirements of an Army Co-operation Squadron, but I hope that you will forgive me if I start with a digression, and a rather paradoxical digression at that.

What I want to say is that " while there are three types of squadron that co-operate with the Army, there is only one Army Co-operation Squadron."

I know that it sounds rather like the Athanasian Creed, but it is nevertheless a fact that I think is sometimes lost sight of.

The three types of squadron are :—

First.—Day and night bombing squadrons, who combine with bombing the duties of long distance reconnaissance.

The tasks of bombing squadrons allotted to an expeditionary force, just as much as those of army co-operation squadrons, are decided by the Military Commander, in consultation, of course, with the Senior Air Force Officer.

Next.—Fighting squadrons whose main duty is to seek out and destroy the enemy in the air and so to establish and maintain air superiority. In special cases, this type of squadron can be used to intervene more directly in military operations by attacking ground targets.

But it must be remembered that the primary *rôle* of the fighting squadrons is the maintenance of air superiority. If they are diverted from this *rôle*, the results of a possible loss of air superiority must be weighed up and accepted.

And finally, the army co-operation squadrons about which I am going to talk to you to-night.

Field Service Regulations is unusually emphatic when it says :—

" A military force will invariably be accompanied by army co-operation and long distance reconnaissance (day-bombing) squadrons. The number of these and the necessity for fighting and night-bombing squadrons will depend on . . . " certain factors, such as the nature of the campaign, and the composition of the enemy air force.

Such squadrons as do accompany a field army will be placed under the command of the Military Commander-in-Chief, and form an integral part of his force.

I stress this point because I think that there is a danger that the soldier, even when well acquainted with the more intimate work of the army co-operation squadrons, is apt to overlook the important functions of the other squadrons that co-operate with the army—functions which, I shall endeavour to show later, have a vital bearing on the efficiency of the work of A.C. squadrons, and hence on the success of the campaign as a whole.

I apologize for this digression, and for the unavoidable confusion of terms, and turn to my legitimate task of discussing the "*Rôle* and Requirements of an Army Co-operation Squadron."

I think that the most logical way of approaching this subject is to consider, first, its *rôle*, and then the requirements that make the fulfilment of this *rôle* possible.

Army co-operation squadrons will normally be provided on the scale of one per Division in the field. They are not, however, divisional troops. They are usually placed under the command of Corps, and the Corps Commander will decide whether to sub-allot them to Divisions for certain operations or to retain them under his own control.

Broadly speaking, army co-operation squadrons exist to further the tactical plans of a commander. The vast majority of their work, though not all, is carried out immediately above, or a few miles ahead of, the front line or the foremost troops. The actual distance to which army co-operation aeroplanes penetrate depends on circumstances.

During the approach march, before contact with the enemy has been gained, they may, and probably will, be required to carry out medium reconnaissance. This type of reconnaissance will take them anything up to 40 or 50 miles in front of the army. At this stage of the campaign, it is practically certain that they would be working directly under Corps and not be sub-allotted to Divisions. Now, the broad principle of air reconnaissance, to which *Field Service Regulations* has given its blessing, is that a commander with aircraft at his disposal is responsible for obtaining information on all matters that would affect his own immediate plans. In the case of a corps, this would not be less than 40 or 50 miles during an approach march. In the case of a Squadron working with a Division, about 20 miles would meet the case. If, in the future, we find ourselves opposed to a highly mechanized enemy, these distances will, of course, be greatly increased.

The type of information that a pilot carrying out a medium reconnaissance would hope to obtain would be troops detraining, columns on the march, bivouac areas, and some indication of the enemy's

mobile troops. He may also obtain valuable topographical information, particularly in an unmapped country such as Mesopotamia was during the war.

I think it will sometimes be useful if these topographical reconnaissances are done by staff officers with air experience, carried as passengers. They could then personally reconnoitre the route by which their formations will advance, the amount of cover available, the nature of the roads, tactical features and the billeting accommodation. Even the best maps are liable to be out-of-date and misleading.

If the enemy possesses an air force, medium reconnaissance would have to be carried out in formations of about five aeroplanes, flying together and mutually supporting each other.

A type of medium reconnaissance, to which I personally attach considerable importance, is one carried out about an hour before dawn. It is at that time that breakfasts are being cooked, and camping ground rubbish burnt, and there is a reasonable hope that the fires will give away the presence of troops who might otherwise remain concealed. I have seen good results from this method, during training at home.

While we are at this point, I would like to touch, for a moment, on the subject of night flying. The probable value of night reconnaissance is rather difficult to gauge in peace. We know that troop movements on roads are visible on clear moonlight nights from aeroplanes flying at quite low heights, and this form of reconnaissance can be practised. But in addition to this, we know that a great deal can be seen by dropping parachute flares from aircraft. Unfortunately, it is not practicable to carry out reconnaissances by this means under peace conditions. There are two reasons for this.

First, the incendiary effect of the flare, if it is still burning when it reaches the ground. During trials on Salisbury Plain, a haystack was accidentally set alight by a flare. As an illuminant, the result was excellent, but the method was unpopular with the owner of the haystack. Secondly, the flare and its parachute are dropped in a container, and, after falling a short distance—to allow it to fall clear of the aeroplane—the flare is expelled by means of a small bursting charge. The container, which is of quite appreciable weight, of course continues to fall, and would deal a knock-out blow to anyone it might happen to hit. Further, all pyrotechnics are notoriously unreliable, and a " dud " flare, falling in its container, would penetrate the roof of most houses. These two reasons debar the use of flares in peace. This is unfortunate, as they are certain to be used in war, and useful lessons may be overlooked.

There is just one point about night flying to which I should like to draw your attention. The pilots of army co-operation squadrons are trained to fly at night, and their aeroplanes are suitable for the work.

At the same time, it is not their normal duty, and, if they fly at night, they cannot be expected to fly all day as well. An army co-operation squadron at war strength consists of three flights of six aeroplanes each, and with this establishment it is accepted that the squadron can keep three aeroplanes in the air throughout the hours of daylight. If much night flying is required, this number must be reduced proportionately.

Now I should like to turn to the more normal functions of the army co-operation squadron, and these fall into three main divisions: close reconnaissance—for which perhaps a more descriptive term is tactical reconnaissance; artillery reconnaissance, which includes the observation of artillery fire; and photographic reconnaissance. The relative importance of these functions will vary with the nature of the operations. While the situation is fluid and operations mobile, I have little hesitation in saying that close reconnaissance will be of primary importance, and artillery reconnaissance will be relegated to the background. As, on the other hand, the situation becomes more stabilized and operations static, the ever-increasing importance of artillery reconnaissance will be felt. Aerial photographs are likely to be demanded at all phases of a campaign, but it is in really stationary warfare that they will prove of the greatest value.

The duties of the close reconnaissance pilot are to carry out such reconnaissances of the enemy's positions as may be required by the Corps or Divisional commander, and to report the positions of our own and the enemy troops and any enemy movements seen. A fairly comprehensive task! It would be quite easy if the pilot could see all that some people are inclined to imagine that he can. It is often thought that it is only necessary to fly over a battle to see the whole thing spread out below you in neat little "packets," rather like the diagrams that one finds in books on military history, under such headings as "the positions of the British and French Armies at Waterloo immediately before the arrival of Blucher."

Unfortunately, it is not so simple. In reality, the pilot sees surprisingly little, and certainly does not get a *picture* of the battle. The sort of thing that he generally sees is the movements of small bodies of troops; signs of digging; suspicious-looking tracks leading into cover, which may denote the presence of tanks, or possibly only dragons, in the cover; a few gun flashes, denoting active batteries; some men outside a wood, which may or may not mean that there are many more inside; a group of officers standing outside an inn holding large white maps. This is certain to be the headquarters of a formation! Of course, every now and then, he gets a real haul, such as a column of troops on the march—possibly the reserve coming up—or enemy tanks moving in the open.

But all these little scraps of information—and there are lots of little scraps—are reported and marked on the general staff map of

the formation with which the squadron is working. And so gradually a picture begins to emerge from little scraps received from the air and from little scraps received from other sources. Then as the picture forms, the commander and his staff can make deductions and draw deductions from each little scrap of information received.

And here I should like to remind you that it is a cardinal rule that the pilot must never attempt to make deductions. His duty is merely to report what he sees. He must never guess, even if he feels convinced that it is a 100 to 1 chance that his guess would be correct. The "guessing" must be done by the staff, who are in a far better position to do so. And this "guessing," or, to be more accurate, "deducing," can be far better done by staff officers on the ground than by staff officers in the air. It is my personal opinion that it is seldom or never advisable for staff officers to attempt to carry out tactical reconnaissance from the air. In the first place, it is rare to find a staff officer with sufficient flying experience to enable him to see anything like as much as a trained pilot. And again, there is a definite danger that he will attach undue importance to what he has actually seen with his own eyes, and be inclined to discount information from other sources which he did not happen to see.

There is another cardinal rule, this time one that applies, not to the pilot, but to the man who receives the pilot's report. And that is, "Never accept as reliable a negative report from the air." If a report is received from a cavalry patrol, that a certain village was not occupied at a certain time, it can be believed implicitly, as presumably the patrol has been there. But a report from the air that there were no signs of the enemy in a village, should be treated with the greatest reserve. It must merely be taken to mean that the pilot did not *see* any enemy, but, as he was obviously unable to go into the houses and look, they may have been there all the same.

I hope that anything that I have said has not conveyed the impression that I wish to belittle the value and importance of close reconnaissance. It is of vital importance, and helps enormously to dispel the fog of war, but it is complementary to the reconnaissance of cavalry and armoured cars. What I have been trying to explain is that it is not so simple and fool-proof as one might at first sight imagine it to be.

So far, in dealing with close reconnaissance, I have only considered reconnaissance of the enemy. There is, however, another side, though one that is, perhaps, of more importance in trench, than in mobile warfare. This is the locating and reporting of our own foremost troops during the course of a battle. The difficulty here lies in distinguishing between friend and foe when things have got mixed up a little in the course of the fighting. This identification difficulty has never really been solved. Theoretically, as laid down in *Infantry Training*, the foremost troops show identification signals at pre-

arranged times, or on reaching certain positions, or when called upon to do so by the close reconnaissance pilot. The signal from the aeroplane—which is specially marked by flaps about a foot square hanging out from the rear edges of the lower plane—is a series of A's on a Klaxon horn, accompanied by the firing of several white Very lights. That is the theory, and it is all perfectly sound in practice, except that there is no satisfactory identification signal for the troops to show. *Infantry Training* refers to flares, white flaps or tin discs.

The flares are excellent from the pilot's point of view, but less popular with the man who has to use them. In the first place, they are of appreciable weight, and, as they are expendable stores, are apt to be expended prematurely by the overloaded infantry soldier by being thrown away. Again, they will not function when thoroughly water-logged, as was discovered during the Passchendæle fighting. And, finally, and this is the most unpopular feature of the flares, they are apt to expose the position of the troops who light them, to the enemy, as well as to the close reconnaissance pilot.

The flaps are pieces of white American cloth attached to the inside of the flap of the gas-mask container. They are of no value, as to see them a pilot has to fly so low, that he is able to distinguish between our own troops and the enemy without their assistance.

The tin discs are intended to be flashed in the sun. The sun has not proved a very reliable agent for communication lately.

So you see, a satisfactory solution to the problem of identification signals still remains to be found, and anyone who produces the solution will be doing a great service. Until a satisfactory type of signal has been devised, the pilot will have to fly very low to obtain his information, and the risks that he will run will be correspondingly increased. Close reconnaissance of our own troops, with the existing apparatus, had reached a high standard of efficiency by the end of the war. There is no reason why it should not be still as equally efficient at the beginning of the next war, but this does not lessen the desirability for finding a better signal.

So much for close reconnaissance. I should like now to say a few words about artillery reconnaissance.

This, as the term applies, is a form of co-operation with the air force which chiefly concerns the gunners, but I think that all officers should have a general idea of what it means.

The duties of the artillery reconnaissance pilot are to locate and report the positions of hostile batteries, to observe, for destruction or silencing, enemy guns or other targets, and to bring artillery fire to bear on hostile concentrations, troops, or transport, on the move. He does all this by means of wireless and a code, with the details of which I won't worry you. There are several variations of his task, and it all sounds rather complicated, but it is not so really. The important thing to notice is that here again, as in close reconnaissance,

the pilot merely reports what he sees. He does not send corrections to the guns—he reports the fall of shells in relation to the target by means of the clock code. The battery commander applies the necessary corrections. He does not bring artillery fire to bear on targets, but merely reports the existence and nature of targets and stands by to observe fire on them if the C.R.A. or battery commander, who has taken in his wireless signals, decides to engage them. The allegation that is sometimes made, that the pilot *controls* artillery fire, is quite without foundation.

You may have noticed that, in speaking of reconnaissance, whether medium, close, or artillery, I have always referred to the pilot. This is because, in all classes of army co-operation work, the pilot does the observation. The passenger is carried entirely as an aerial gunner, to look out for, and help to fight, hostile aeroplanes.

There are several reasons for this. First, an aeroplane is a difficult thing to see out of; the wings have a habit of getting in the way, and the only person, who can ensure that he can get an unobstructed view of an object on the ground, at a given moment, is the pilot. Flying an aeroplane, when well clear of the ground, does not require constant attention. A pilot has always a hand free, to tap a wireless key or write a message. Another reason is that, even if he were not carrying out the reconnaissance, a pilot would have to devote a good deal of attention to the ground, so as to try to get into the right place for his observer to see. Experience in France proved very conclusively that one man in a two-seater aeroplane should spend his whole time looking out for attacking enemy aircraft. Hence we have come to regard it as a principle that the pilot should do the observation, and I have never heard any serious doubts cast on the soundness of this principle by anyone with considerable war flying experience.

The last of the normal duties of the army co-operation squadron is photography. There are, as I have no doubt you all know, two types of aerial photographs—oblique and vertical.

Oblique photographs are taken from a low height, with the camera pointing at an angle of some 60 degrees from the vertical. The result is the same sort of view as one gets by standing on a high hill and looking out over the country. Vertical photographs are obtained by pointing the camera vertically downwards. The result is, of course, a map-like representation of the country. While the vertical photograph is really of more value, it takes something of an expert to read it. The oblique photograph, on the other hand, gives a very good idea of the topographical features of the country, and is very useful for letting troops know what sort of country they can expect during their advance.

By the end of the war, the demand for aerial photos was enormous, sometimes as many as a thousand being taken daily. During mobile operations, photography has its limitations. First, there is the time

factor. The time between the ordering of a photograph and the delivery of the prints varies with such circumstances as the weather, the distance of the object to be photographed, the distance of the army formation from the squadron aerodrome, and the number of photographs. As a very rough guide, under favourable conditions, the time may be taken as between six and twelve hours. Another very serious limitation is the height of the clouds. Although this does not affect the taking of oblique photographs if the visibility is good, low clouds will prevent an area being covered by vertical photographs.

The main photographic task of an army co-operation squadron during a battle is the corps counter-battery area; that is to say, the area in which hostile batteries are likely to be sited.

In addressing an audience such as this, I need not refer to the value of air photography as an aid to survey, except to say that, with the improvement of apparatus and technique—both in the air and on the ground—the potentialities are rapidly increasing.

Before concluding what I have to say about the *rôle* of an army co-operation squadron, I would like to offer a few suggestions as to the uses that Royal Engineers might make of aircraft

In unmapped and undeveloped countries, where water is likely to be scarce, or where the water supply is intermittent, air reconnaissance may be invaluable in reporting the presence, or otherwise, of water, and also on the possibility of the enemy being able to cut off the supply.

Again, in dealing with the passage of obstacles, whether natural or artificial, a short flight may often be the means of obtaining as much information as hours of travelling on the ground. For instance, it may be possible to say whether bridges have or have not been destroyed; but I must warn you that this is sometimes more difficult than might at first appear to be the case. From a considerable altitude, the roadway of a bridge that has been blown, may often appear intact. The damage may only be discernible to a pilot flying quite low, or by means of a very large scale photograph.

It will often be possible to discover the existence of fords, by noticing that a road or track runs down to a river and emerges again the other side. This may, of course, denote only a ferry, but if it is, there will usually be some evidence, such as boats, landing stages, or the ferryman's cottage or hut, to indicate it. The depth, the strength of the current, and the nature of the bottom, must, of course, be ascertained by subsequent ground reconnaissances.

Obstacles on roads, such as craters, felled trees, or trenches, will usually be visible either to the eye or to the camera. Air reconnaissance and photography will prove invaluable in helping to decide how such obstacles can best be circumvented, and what material is available in the vicinity for repairs. The use of camouflage, either to

conceal obstacles or stimulate obstacles, is perhaps worth considering.

In regard to survey work, not only will air photographs be invaluable for rapidly producing rough maps of unmapped country, and for supplying the detail for accurate maps, but a preliminary reconnaissance of an area may save hours of fruitless labour to survey parties, by determining the best routes for them to take. If the best value is to be got out of any of these reconnaissances, I think that it is often advisable that an engineer officer should be carried as an observer in the reconnoitring aeroplane.

In the time at my disposal, I think that that is all that I can usefully say about the *rôle* of an army co-operation squadron, so I will now try to sketch quite briefly the requirements of such a squadron.

First, as to the type of aeroplane that is suitable for the purpose. This is a two-seater, with the pilot in front and an aerial gunner behind. The pilot is armed with a fixed Vicker's gun, synchronized to fire through the propeller. The gunner has a movable Lewis gun. The aeroplane must afford the pilot a good field of view all round, and particularly towards the ground. It must be sufficiently roomy to accommodate the wireless set, camera, ammunition, Very lights, etc., that have to be carried. It must be able to stay in the air for three hours or more without refuelling, and must be able to land and take off from a fairly confined space. It must have a fair turn of speed, and, above all, must be "handy" in the air. An army co-operation pilot should not seek a fight, but he must be able to defend himself if attacked, and the "handiness" of his machine will be a great assistance to him in this.

But what he really depends on for his protection are the fighting and bombing squadrons, to which I have already alluded. It is their task to gain and maintain air superiority—the bombers by attacking enemy aerodromes, and the fighters by seeking out and destroying the enemy aeroplanes in the air. You notice I say "seeking out." It is no use waiting for them to come—the fighters must go and look for them. As was proved times and again in the War, a defensive attitude in the air is useless. The efficiency of the work of the army co-operation squadron will depend directly on the success obtained in the fight for air superiority. If they are to do their work properly, they must be reasonably free from interference.

This is why air superiority is so vital to an army in the field, and why *Field Service Regulations*, in discussing the duties of aircraft, says: "Among such duties and responsibilities, the *most important* will be the attainment and maintenance of air supremacy." The side that does not possess it is blinded and will be harassed by attack from the air; the side possessing it can do much to pierce the fog of war, and will be relatively immune from the menace of being bombed.

Now let us turn to the ground organization of a squadron, and see what is required there. I have attached to your précis, as an Appendix,* an outline of the organization of an army co-operation squadron. From this you will realize that it is a fairly complicated machine. Like any other complicated machine, it should be protected from the weather, and should be moved about as little as possible. As regards housing, the provision of all buildings, hutments and works for the air force in the field, is undertaken by the Director of Works, so we rely very largely on the Royal Engineers for our comfort and thus for our efficiency. Of course, in war, comfort is a relative term. Although a front-line dug-out can never be as comfortable as a *château*, yet there are degrees of comfort even in dug-outs, and it is my firm conviction that, in the interests of efficiency, one should always be as comfortable as circumstances permit. From the air force point of view, I feel that this is doubly important. War flying is unquestionably a severe strain. I think that this is because the risks come in rather concentrated doses. Taken over a period during the war, it is surprising to find that few pilots exceeded an average of one hour's flying a day. Yet in that one hour, the risks, on the basis of casualties, were at least equivalent to those run by other arms in 24 hours. The more comfortable pilots can be made on the ground, the better they will be able to withstand the abnormal tension. To take another side of the case, photographs can be developed and printed in the special photographic lorries that form part of every army co-operation squadron, but the interior of a lorry is congested, and becomes intolerably hot in summer and bitterly cold in winter; better results will be obtained if a hut with water laid on can be made available. Similarly, an aero-engine can be overhauled in the open, but the work can be done more quickly and better under cover.

Of course I am visualizing fairly stable operations here. It is obviously impossible for us to expect much help from you in this direction when things are moving rapidly, and under such conditions we must take our chance with the rest.

But, however mobile the operations may be, it is most important that the ground organization of a squadron should be moved about as little as possible.

Let us say an army is advancing at the rate of 10 or 15 miles a day. There is no use in moving the squadron this distance. It is infinitely better to leave it alone, and let it make big bounds of 50 or 60 miles every four or five days. In the meantime, a series of advanced landing grounds are selected, in short bounds, keeping pace with the army. Aeroplanes can use these advanced landing grounds for landing on, to make reports, or to refuel and replenish ammunition and bombs, and can return to the squadron aerodrome at night for maintenance and adjustment.

* (Not reproduced.)

As it may fall to the lot of any army officer to have to select one of these landing grounds, and as I know of a good many instances where aeroplanes have been crashed through unsuitable landing grounds being chosen, I will try to explain exactly what is required. The site chosen should be about 400 yards square, not on a pronounced slope, and of a sound and fairly smooth surface. A grass field is the best, but beware of ridge and furrow, which will make an aeroplane bounce, and will probably result in a broken undercarriage. Stubble is quite good. Wet plough is hopeless, and will almost certainly turn a machine over; dry harrowed plough would serve. A very important point to look to is the approaches. If there are trees, houses or telegraph poles round the spot selected, the size will have to be correspondingly increased. As you know, an aeroplane lands and takes off up wind. The pilot may know the direction of the wind by smoke or something like that, but, on the other hand, he may not. To show him the direction of the wind, a T made of white cloth is put out, with the head facing into the wind. The pilot lands along the stem of the T. He will usually try to touch his wheels first on the T, so be sure that the going in prolongation of the stem of the T is good. It is also worth remembering that a landing ground should be accessible to 3-ton lorries.

Another important consideration in selecting an advanced landing ground for an army co-operation squadron is that it should be as close as possible to the headquarters of the army formation with which the squadron is working. Good ground communications between the squadron and the Corps or Division are vital. It is obviously useless for pilots to obtain information if it cannot be transmitted quickly to the proper quarter. The ideal is a direct telephone line to the headquarters concerned, but this can only be hoped for in moving warfare if the aerodrome or landing ground is reasonably close.

The communication difficulty is partially overcome by having direct communication between the aeroplane *in the air* and the headquarters. This is arranged for in the case of aeroplanes carrying out close reconnaissance by means of two-way wireless telephony. The reliable range of the sets used at present is only 10 miles, but this will, of course, be increased in time. In the case of artillery reconnaissance, one-way wireless telegraphy is used. Further, for medium reconnaissance, two-way telegraphy is used, the sets having a range of about 200 miles. So you see that a squadron has a good many different types of wireless sets to handle—to be exact, it has 62 sets, comprising six different types. A complicated component of the complicated machine! The wireless is supplemented by message-dropping, and, in cases where information about our own troops is concerned, this is the only safe way of conveying it, as it would be obviously undesirable to broadcast such information by wireless.

As a method of communicating with the aeroplane when other means are not available, message picking-up can be resorted to. This is done by tying the message to a cord and suspending the cord between two poles, or rifles stuck into the ground by their bayonets, about ten feet apart. The army co-operation aeroplane has, as part of its normal equipment, a hooked stick hinged to the undercarriage, which can be allowed to hang down when necessary. The pilot flies low and hooks up the cord with the message with the stick, pulls it up, and reads it. It sounds crude, but works quite well in practice.

The ground communications of the R.A.F. are the responsibility of the Royal Corps of Signals, message dropping and message picking-up is a combined responsibility, and wireless communication between ground and air is an Air Force responsibility.

That is all that I have time to say about communications of an army co-operation squadron, but I hope that it is enough to give you an idea of the system and methods employed. Good communications, both on the ground and between the ground and the air, are a fundamental requirement of an army co-operation squadron. If communications fail, the squadron cannot possibly pull its weight, however well equipped, or highly trained, it may be in other respects.

To turn to one more point. Aircraft on the ground are very vulnerable, and require protection. Airmen are drilled and armed, and are fully capable of looking after themselves, but, as you know better than anyone, one cannot have it both ways. If an E. and M. Co. is put on outpost duty, the lights will probably go out. If an R.A.F. Squadron is required to protect its own aerodrome against sabotage during a period of unrest, or to picket the heights on the North-west Frontier while a breakdown party is collecting an aeroplane that has been forced to land, the aeroplanes will soon cease to fly.

In conclusion, I would like to refer to what is perhaps the most important requirement of all, and that is, that officers of the army should possess a sympathetic understanding of the difficulties and limitations of an army co-operation squadron. There is no black magic about it; it is all perfectly natural and straightforward. If you will allow me, I will close with a quotation from *Field Service Regulations*, which puts the point far better than I can hope to do:—

> "The full power of an army can be exerted only when its parts act in close combination, and this is not possible unless each arm understands the characteristics of the other arms."

THE 23rd (FIELD) COMPANY R.E. IN THE GREAT WAR, 1914–1918.

(Continued.)

By MAJOR R. L. BOND, D.S.O., M.C., R.E.

PART II.—THE MARNE, THE AISNE, AND 1ST BATTLE OF YPRES.

Battle Honours during the period—"Marne 1914," *"Aisne* 1914," *"Ypres* 1914," *"Langemarck* 1914," *"Gheluvelt," "Nonne Boschen."*

DURING the night of the 5th/6th September, the welcome and eagerly expected orders were at last received for the advance to begin. The 23rd (Field) Company was allotted to the advance guard, the 1st (Guards) Brigade; No. 2 Section was detailed to move with the vanguard, the 1st Coldstream Guards. The vanguard moved out of Rozoy about 8 a.m., but had only marched about two miles when the enemy were encountered, apparently holding some farm buildings and surrounding hedges. The country was very open, and the battalion at once deployed in accordance with the pre-war training, into a series of lines, men being at about five paces interval. No. 2 Section wagons were placed under cover behind a small house, and the house, garden, and haystacks reconnoitred with a view to construction of a strong point in case the attack should be held up. There was some rifle and shrapnel fire, but few casualties were experienced, and, as the attack was apparently going well, No. 2 Section deployed and commenced to advance ahead of the reserve company.

All at once, for some reason that appeared incomprehensible at the time, orders were received to break off the fight and withdraw. The advancing lines turned about, and, still deployed, moved back towards Rozoy, followed by a few shrapnel. One man of No. 2 Section was slightly wounded. The withdrawing units began to catch up the leading battalion of the mainguard, which was also moving back, and a tendency for the troops to bunch in on the road became manifest. As the enemy was still following up with gun-fire, this seemed somewhat dangerous. No. 2 Section, therefore, lay down deployed, and when the road became clearer moved steadily back, finally marching in as if on parade, being complimented on their smartness and steadiness by the G.O.C. 1st Brigade.

After a long wait in Rozoy, the march recommenced, and was

completed without further incident, the company bivouacking in an orchard at Le Plessis. Everyone felt much brighter, now that the movement was in the right direction, and the unit had proved its steadiness under fire sufficiently to draw the commendation of the exacting commander of the 1st Brigade.

The following day, the 7th, the march was without incident, by very cross-country routes, lanes and woodland tracks, to Le Trenois, again "a comfortable orchard bivouac," as the diary calls it.

On the 8th, the 23rd was again with the advanced guard, and there were strong expectations of coming into contact with the enemy. Actually, as the company following the Black Watch in column of route came to the crest of the hill, leading down to the Petit Morin, near Sablonnières, a shell, fired at long range, fell amongst the battalion stretcher-bearers immediately ahead, followed by several more on the right of the road. The wagons were rapidly got clear of the road, the sections deployed in accordance with a regular drill that had been worked out for such an eventuality, and moved forward to the cover of some buildings, where a considerable halt took place. The advanced guard was, in the meantime, fighting a sharp action by the stream, in which, however, the company took no part, and, as all bridges were intact, eventually continued the advance, getting into billets in a splendid barn on a high plateau south of the Marne, at Basseville Farm. This farm, almost an old manor house, had only shortly before been evacuated by the enemy, and the owner, to show his appreciation of our arrival, gave us an excellent dinner, and produced some of his mellowest *vin rouge*, which he had successfully hidden from his previous unwelcome guests. Shortly after the company got into billets a very heavy thunderstorm broke, producing one of the finest rainbows the writer ever remembers to have seen.

The next day, September 9th, was only a comparatively short march, the Marne being crossed at Nogent L'Artaud, where again the bridges were intact. There was some excitement at this point, as there appeared to be a considerable battle in progress to the west, about Château-Thierry, but it was difficult, even with glasses, to identify the columns of troops that could be seen on the move near that place. The march ended in a bivouac at La Nouette Farm.

On the 10th, the 2nd Infantry Brigade, the advanced guard of the 1st Division, had a sharp fight with an enemy rearguard near Priez, but the 23rd (Field) Company, following behind, were not involved. The Company billeted that night at Latilly, and the following night, after an undisturbed march, at Bruyères.

It must be remembered that, in 1914, although infantry units had "cookers," the high authorities took the view that the sapper could get on well enough without hot food, and these invaluable aids to morale were not issued to R.E. units. Neither did an officers' mess cart figure on the establishment. The latter need was supplied at

Bruyères, where a fine black-hooded two-wheeled species of gig was purchased for 25 francs, and, drawn by a spare horse, was the most valuable possession of the Company, and the joy of that excellent cook, Corporal McCrory, until 1917. From time to time, most heartening signs of the hurried German withdrawal were apparent.

The 12th was a day of heavy rain; a long march over winding roads, descent into the valley of the Vesle by Mont Notre Dame, with its interesting old church, and a climb up the steep and muddy hills, brought the company to a most comfortable billet at Paars, a few miles south of the River Aisne.

The following day, the 13th, was to be the last genuine pursuit of the enemy that the B.E.F. was to enjoy for many, many a long day.

The company was early astir (breakfast at 3.30 a.m.) on the 13th; there were rumours that the enemy was counter-attacking, and a rapid reconnaissance of Paars produced a fair number of the long-handled shovels peculiar to the district, which were issued to the 2nd Infantry Brigade (the advance guard), which was busily digging in on the crest of the hills near Vauxcéré, overlooking the Aisne valley. The Company assisted. About 8.30, a message was received from the C.R.E. for two officers to go forward and reconnoitre the river crossings. Capt. Addison and Lieut. Bond rode forward and joined the C.R.E. and Adjutant in the shelter of a group of houses near the bridge over the canal south of Bourg.

Here the divisional cavalry, a squadron of the XV Hussars, were in action with enemy posted in the houses of Bourg. One or two troopers who had ventured into the open were shot. It was difficult, therefore, to get a view of the bridges, but by careful use of the nearby mill buildings and the bushes by the river bank, it was possible to discover that the main road bridge over the River Aisne, which at this point ran in a deep gully, had been demolished, but the attempt to blow up the aqueduct carrying the canal over the river had failed, and the wide towpath was passable for wheeled traffic. Closer inspection of the manager's house at the mill showed that the Bosche officers had had a hasty but complete breakfast, mainly of "bubbly," to judge by the débris, and were no doubt fully fortified for the battle. By midday, the cavalry and advanced troops had succeeded in making good their footing on the north bank of the river, and the Division then commenced to cross by the canal towpath. Owing to the nature of the banks and surrounding fields it was not possible to leave the towpath at once on crossing the bridge, but the column had to move almost a mile along the towpath to a point where a short deviation was made by the 23rd Field Company, leading on to the Bourg-Vailly road, a corduroy road being constructed of timber found near the site.

The towpath was hard put to it to stand the strain of the traffic, and the Company was fully employed in keeping the surface in con-

dition, rapidly filling up holes with whatever material was handy, in the intervals between units, and suffering the objurgations of gunners temporarily held up by more than usually extensive repairs, whilst from time to time a long-distance shrapnel shell from the Chemin des Dames would fall with a sizzle into the water.

At last, however, the crossing was complete, and the 23rd Company, following after the column, moved up the long valley from Bourg, to bivouac for the night at the foot of the hill near Paissy. Sketch No. 6 is a somewhat indifferent panorama of the 1st Division battle-ground, taken from the Pargnan spur at the time.

It will be remembered* that, on the morning of the 14th September, the 2nd Infantry Brigade was ordered to seize the Chemin des Dames about Cerny, prior to the advance of the Divisional Advanced Guard, the 1st (Guards) Brigade. The 23rd (Field) Company moved with the latter at daybreak, but, before this, a tremendous outburst of rifle and machine-gun fire showed that the 2nd Brigade was already hard at it. The move by Moulins to Vendresse was not a comfortable operation, and the Company was fortunate in having no casualties from the increasing shell fire. After reaching Vendresse, there was no move for some time, and as the battle became more and more severe on the hill crest but a short distance in front, the C.R.E. ordered the Company to commence the construction of a rear line of strong points on the spur and curious sugar-loaf hill between Moulins and Vendresse. After digging the fire-trenches of these strong points, the sections manned them for a time, but about midday received orders to move to Paissy to carry out similar work. An excellent position was selected on the crest of the hill, and work was just commencing when the order was received to return to Vendresse, but no further work was required, and the Company went into bivouac at Moulins.

At 10 p.m., Nos. 2 and 3 Sections were ordered to assist the Queen's Regt., 3rd Infantry Brigade, who were in battle outposts on the Chemin des Dames, north-east of Troyon. The night was dark, it was pouring with rain, distances, as always, were deceptive, and also the run of the valleys and ridges, and it was only after prolonged reconnaissance that the Queen's were found, lying in an attenuated line along the small bank by the side of the Chemin des Dames road. The battalion had had a very heavy day's fighting, and the men were worn out and quite incapable of digging. It was, therefore, apparent that the best assistance the two Sections could give was to dig some cover for the troops to get into. A very considerable length of fire-trenches was dug some 80 yards on the enemy's side of the road, as it was obvious that trenches on the road must be a clear mark for hostile guns. The Sections provided their own patrols for security. Before finishing the work the parapets were camouflaged with turnips, the work being carried out in a turnip field. When complete, the

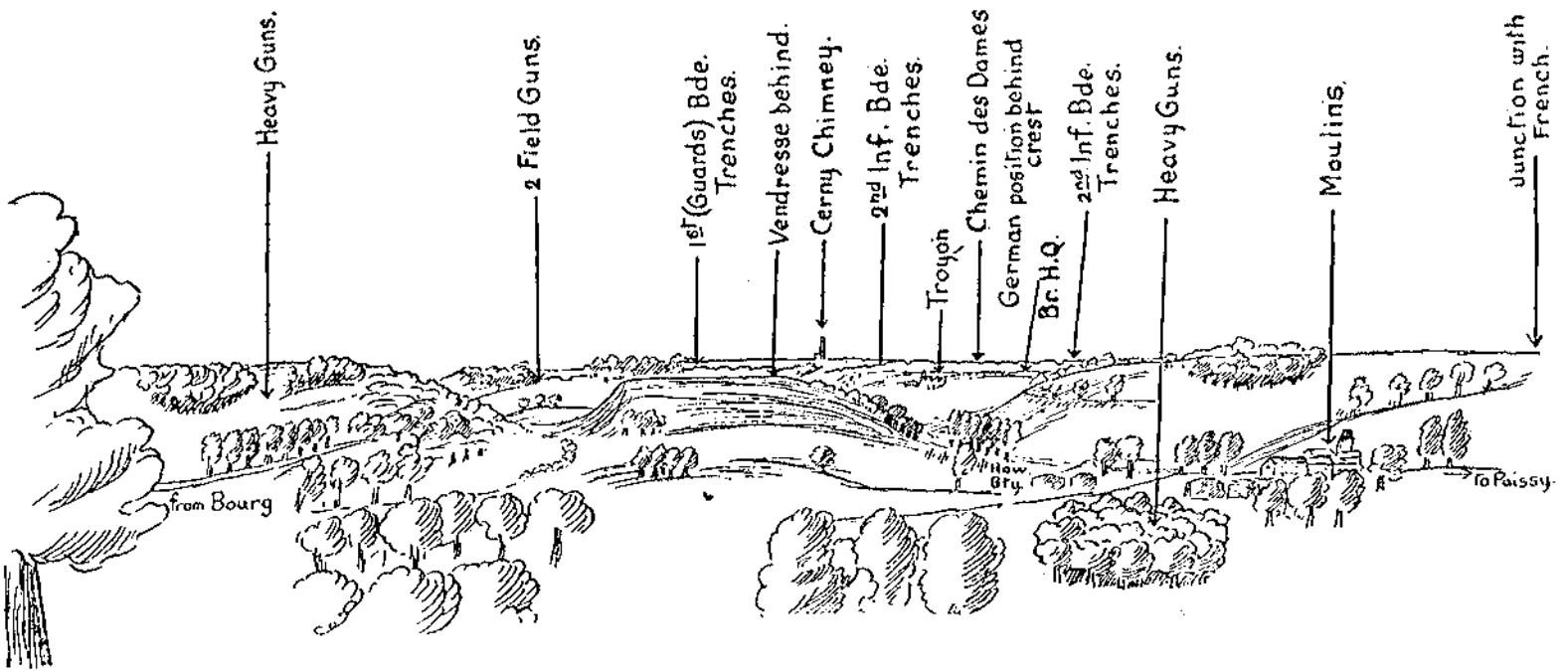
* *Military Operations, France and Belgium*, 1914. Vol. I, p. 341.

BATTLE OF THE AISNE.

Sketch No. 6.

Panorama of 1st Division front, from Pargnan spur looking N.W.

(From Sketch made at the time.)



nearest senior officer who could be found was informed of what had been done, and the Sections withdrew.

Some way to the left of our position, a haystack was burning fiercely, and throwing an eerie flickering light on the wet road and wet waterproof sheets, whilst a pervasive smell of burning straw soaked into the brain. There are no more potent remembrances than the senses of smell and taste, and the pungent smell of burning straw infallibly brings an instantaneous picture of that weird, wet, firelit battlefield flashing to the brain ; just as frying bacon conjures up visions of early mornings in the Cambrin trenches, and Staff College tea the chlorinated horror of a Zonnebeke pillbox.

Early on the morning of the 15th, the Company moved its position, owing to the unwelcome attentions of the enemy, but wherever a new pitch was staked out gunners appeared before and behind, soon to draw retaliation which made a further move imperative. All this time, the battle was in full swing about Cerny and Troyon, heavy losses were being incurred, and about 9 a.m. the situation appeared so serious that the 23rd (Field) Company was sent up to the 1st (Guards) Brigade to act as brigade reserve. The four sections, with bayonets fixed and magazines loaded, concentrated a short distance in rear of the attenuated firing line, which was in fair shelter behind a bank on the near slope of the hill. However, the anticipated attack failed to materialize, and the situation becoming more satisfactory, the Company withdrew to billets at Moulins. Here it remained during the following day, except for No. 4 Section (Lieut. Stafford), which moved to Villers to assist the 1st Field Squadron in the repair of bridges at that place.

From this date commenced trench warfare, and it will be desirable to indicate in general the work and method of employment of the Field Company, rather than follow its fortunes day by day.

First of all, however, in order to realize the conditions under which the hard lessons of trench warfare were slowly learned, the doctrine of the organization of defence at this period must be understood. The defensive had received a good deal of study in the couple of years immediately preceding 1914. In the summer of 1913, the 1st Division at Aldershot had carried out a 24 hours' working party exercise, at full strength, in the Mytchett area, in the construction of a defensive position on a front of about 4,000 yards.

The scheme of defence, based on doctrine of which the C.R.E. 1st Division (Lt.-Col. A. L. Schreiber, D.S.O.) was the chief apostle, consisted of a series of strong points, mutually supporting, carefully sited to economize numbers and ensure the best field of fire, and camouflaged from ground observation, even to the extent of removing clumps of trees and replanting them in front of the trenches. The support companies were to be in similar works in rear.

Each defended locality, or " point d'appui," as it was called (an

unfortunate term which, overworked, became a source of some ribaldry amongst the lesser fry), consisted of three or four separate lengths of normal three-task fire-trench, with a few yards' interval between each, but in principle on the lines which proved entirely sound in the course of the War. The position as a whole had not any great depth, the reserves not being entrenched, but kept concentrated and mobile. The Field Companies were employed on the lay-out of the defences, issue of tools, supply of guides, construction of overhead cover, and the " camouflage " of trenches, though the word did not come into use until much later. The principle of the strong point and supporting point was therefore well understood.

As a result of the fighting on the 14th and 15th September, 1914, the 1st Division, after suffering heavy losses, found itself lying in a long thin line ; on the right, along the edge of the Chemin des Dames, then bending back on the reverse slope of the crest between Cerny and Troyon, behind a low bank formed by a sudden change of field level, which ran for a considerable distance along the Chivy spur. Behind this bank the attenuated platoons had found effective shelter from the enemy's artillery fire, and so rapid and accurate was our rifle fire that enemy attacks were wiped out even in the short field of fire between bank and crest. Here the men dug themselves in, first into one-man holes, then into continuous narrow trenches, for which the Field Companies were soon to provide much-needed traverses.

Digging in in this manner, every man fired straight to his front, and as there were practically no troops available behind the front line, it was soon found that any gap in the line, even of 100 or 200 yards, was apt to be discovered by the enemy, especially at night, with the most unfortunate results. Everyone's energies were therefore concentrated on ensuring that no gaps occurred. So far as the forward defences were concerned, our friend the *point d'appui* was a thing of the past. Nevertheless, under the instructions of the C.R.E. a number of strong points were constructed by Field Companies on important features further back. The 23rd (Field) Company spent several days in the construction of a true defended locality at Pargnan, also at Paissy, and on the Moulins spur. The Paissy locality was commenced on the night of a serious break in front due to the unduly early withdrawal of an Algerian battalion on the right. The situation was restored, after some anxious moments, by General de Lisle's Cavalry Brigade, and the eventual arrival of some units of the 18th Infantry Brigade. The commanding officer of one of these battalions was much attached to an antique pipe, which he unfortunately dropped in the course of his reconnaissance. The writer spent a remarkable twenty minutes assisting in the search, crawling on his hands and knees amongst the overgrown beet in the light of the stars well in front of the forward infantry line. The faithful briar, unhappily, was not to be found.

After the first ten days, a system was inaugurated of two sections living in forward billets at Vendresse, the remainder of the Company being kept in reserve. The forward sections at first were employed on traversing fire-trenches, improvement of a second line of trenches which were now beginning to appear, in sapping in typical siege-warfare fashion to get trench lines in certain places nearer the enemy, and the construction of wire entanglements along the front trenches—the latter a somewhat ticklish task, as any small disturbance led to a rapid outburst of fire from both sides, until we insisted on hostages from the infantry coming out with the wiring parties. Screw pickets were not invented, and wire was mainly of the low variety, laid three bays wide, muffled mauls being used; though the irrepressible wit who invariably fell over spare coils, hit other people on the thumb, and then laughed at his rotten joke, made these efforts at silence of little value. However, by marvellous good fortune casualties were rare.

During this period, H.Q. and the rear sections were billeted in Bourg, but for two days the Company moved to Villers, where Nos. 3 and 4 Sections were employed in strengthening the barge bridge to enable it to take heavy transport. This was effected by building up crib piers close to the gunwales on either side of each barge to replace the central transoms, thus doubling the number of transoms throughout the bridge.

One cannot leave this account of the work done on the Aisne without reference to the first efforts in field survey carried out by the O.C., 23rd (Field) Company. Maps were not sufficiently accurate for "predicted" shooting, but very soon after trench warfare commenced "R.B." was at work with his plane Table. The first essay was in fixing the positions of a field-gun and a machine-gun so that they could fire in enfilade down a road leading to Cerny, which it was apparent the enemy would be bound to use for transport at night.

Later on, the survey was extended to fixing the positions of the 6-in. howitzer batteries, O.P.'s and so on, a much-needed work, for, as invariably happens in peace and war, the battle was fought on the edge of two maps, one of which was the French hachured article, the war having tactlessly gone beyond the boundary allotted to it by our G.S.G.S. of 1914.

On the 15th October, the French took over the 1st Division line, the 23rd (Field) Company maintaining an observation party on the Bourg bridge during the withdrawal. No. 4 Section came in from Vendresse during the day, and from Stafford's lurid account of the day's doings, the Company forward billets had ceased to have any attraction.

At 6 a.m. on October 16th, H.Q. and Nos. 1 and 2 Sections marched to billets at Perles, Nos. 3 and 4 going to Pont Arcy to dismantle a pontoon and trestle bridge at that place. They rejoined at 8.30 p.m.

Nos. 1 and 2 Sections moved to Pont Arcy at 7.30 p.m. to dismantle the main pontoon bridge of, writing from memory, 12 piers. The French had not yet completed their bridge, and it was not considered advisable to remove our bridge until the French communications were satisfactory. Work was not commenced until 11.30 p.m., and owing to the pontoons having been in the water for a month, the river running fairly fast, and the narrow lane approaching the bridge being steep, cobbled, and slippery, it took till 1.30 a.m. to dismantle the bridge and pack wagons. These Sections rejoined at Perles at 4.30 a.m., on October 17th, having marched 27 miles during the previous 24 hours, and dismantled the bridge. The day's rest on the 17th was, therefore, fully appreciated. At 2 a.m. on the 18th, the 23rd (Field) Company entrained at Fismes ("side loading on to end loading trucks as usual," says the diary), the Battle of the Aisne was over, and the curtain was now to ring up on even more stirring deeds.

That the Sappers had taken their full share of the work is evinced by the following message to the C.R.E. from the G.O.C., 1st Division: "Please congratulate the 23rd and 26th Companies under your command on the excellent work done by them during the Battle of the Aisne, which lasted 31 days. The skill and courage shown by them in strengthening the infantry trenches night after night, and often under fire, reflected the greatest credit on all ranks of the two Companies. The infantry who benefited by their skilled work greatly appreciated their assistance."

YPRES, 1914.

The 18th October and the greater part of the 19th were occupied in the train journey to the north, passing through the outskirts of Paris, thence by Amiens and Boulogne to Cassel. The journey was slow, there appeared to be trains 200 yards apart all along the line, and it was no difficult feat to get out and walk, or even to stop and indulge in a hasty wash at a stream, catching up after a short run. On detraining at 8 p.m., the Company marched back to billets at Hazebrouck.

On the 20th, the Company, marching at the rear of the Division, billeted in the big brewery at the west end of Poperinghe—a very fine billet for all ranks. The officers remember with gratitude the excellent dinner provided by the manager and his wife, the liberal cellar, and the subsequent entertainment, for both host and hostess sang delightfully. This house escaped injury throughout the war.

The 21st was once again a day of battle, for the Division, moving on Poelcapelle, met the enemy about Langemarck. The Company, though ordered up at 1 p.m. to the neighbourhood of Pilkem, was not engaged. The Sections moved up at 8 p.m. to the front, to assist the 1st (Guards) Brigade by clearing the field of fire, but work had barely commenced when dispositions were changed, and the Guards batta-

lions took up a line further in rear, on which no assistance was required at the time, wire not being available. The Company billeted for the night near Pilkem.

It will be remembered that on the following day, the 22nd October, the heavy fighting of the Battle of Langemarck took place, the attack of the German Fourth Army on the 1st Corps and 7th Division. The Yser canal ran along the whole length of the rear of these formations, and as there was no bridge between Ypres and Boesinghe, a three-and-a-half mile stretch, any forced retirement would have caused the most serious difficulties in withdrawal of guns and transport. The 23rd (Field) Company was, therefore, ordered to construct a bridge half-way between the above places.

By good fortune, at a very good spot, two large barges had been abandoned. These had been swung across the canal and a footbridge constructed across them. As the approaches to the canal by these barges were as good as could be found, work was at once commenced on a medium bridge. Sketch No. 7 shows details of construction. It was found that the ordinary mud shoes on the Weldon trestle legs did not prevent undue sinkage in the mud of the canal, and fascines were, therefore, bound longitudinally under each pair of legs, in a manner tried out at the bridging camp in the early summer, and gave excellent results under full loads.

Work was continued in shifts night and day, and was completed in 29 hours, by 5 p.m. on the 23rd. A considerable amount of work was carried out on the approaches owing to the height of the canal banks. Small subsidiary bridges over a couple of streams were also constructed. Work was interrupted during the night by orders to move to Boesinghe and occupy a position there, but on arrival the trenches were found tenanted by the 2nd Infantry Brigade, and the Company returned to work.

The 24th was spent in putting finishing touches to the work. The G.O.C. I Corps (Sir Douglas Haig) and his B.G.G.S. inspected the bridge. Although, happily, the necessity did not arise for urgent use of the bridge, it provided admirable bridge-crossing practice for a squadron of French Chasseurs, who made the passage some seven or eight times in the day. The horses became quite tame after the fifth round.

The 25th was a day of rest, and arrangements were made to hand over the bridge to a Company of French Engineers, after removal of bridging equipment.

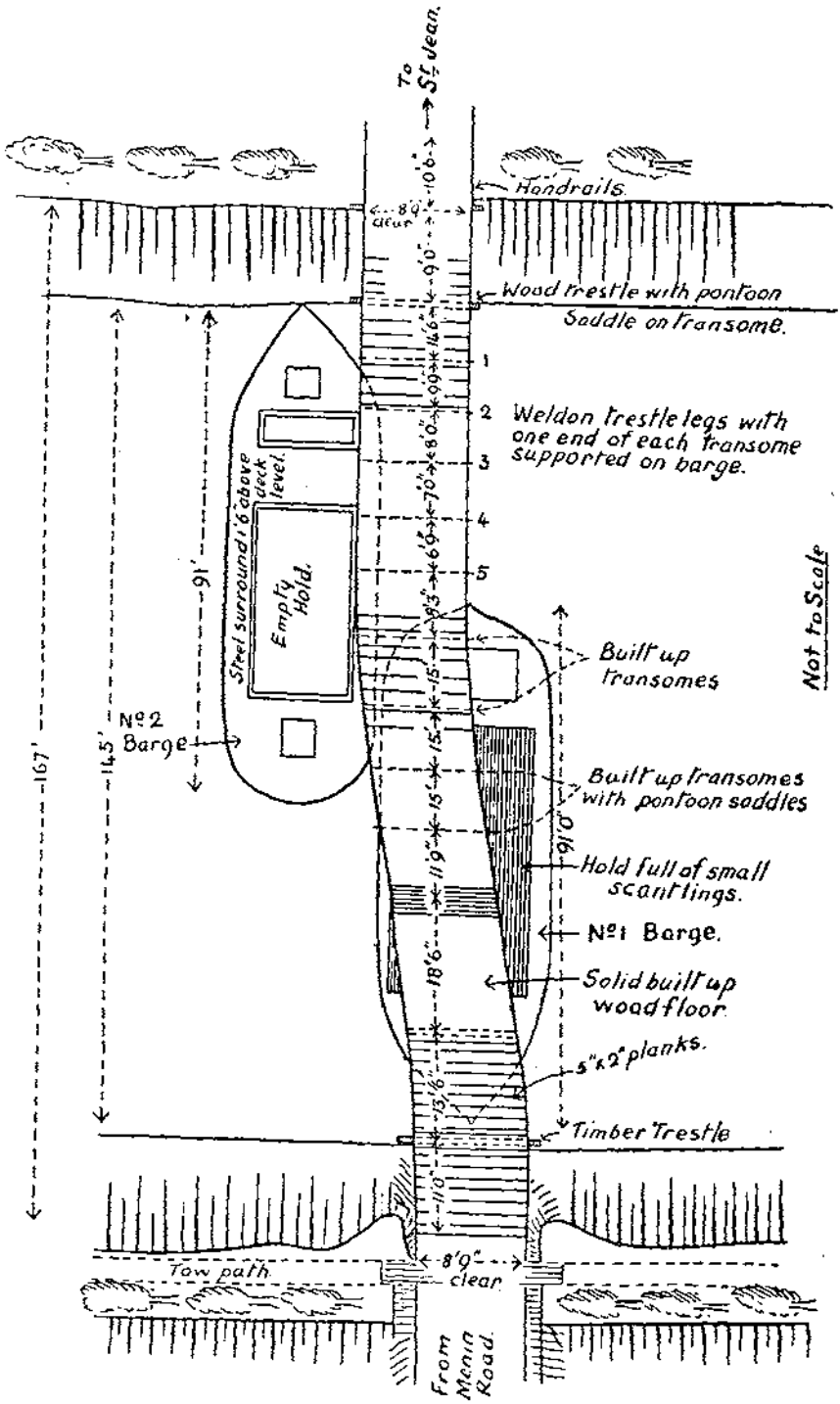
Sketch No. 8 illustrates the activities of the Company during the forthcoming operations.

On the 26th, the Company moved through Ypres to a *château* about 1½ miles out, on the Menin road, where it was in Divisional reserve with the 2nd Infantry Brigade. Some work was done in the preparation of an aerodrome for the Royal Flying Corps.

Sketch No. 7.

SKETCH OF BARGE BRIDGE OVER YSER CANAL.

23rd (Field) Company, R.E. Oct. 22nd–23rd, 1914.



The 27th provided a strenuous day's work. The Company moved forward to a bivouac beside the grounds of what was afterwards Stirling Castle. From 1 p.m. to 6 p.m., the Sections were employed in improving the communications through the Herenthage woods towards Gheluvelt, communications urgently required for the movement of artillery ammunition wagons. The Menin road was already becoming thoroughly unhealthy, and alternative routes were lacking. The work consisted in making a bridge over the Basseville stream south of the *château*, completing a corduroy road through the wood leading to Gheluvelt, and erecting notice boards. At night, the sections moved forward to the Kruiseeck cross roads, to assist the 1st (Guards) Brigade. An attempt was made to strengthen the group of buildings at the cross-roads, by the erection of a wire entanglement, but the small quantity of wire available made this an indifferent obstacle. The existing barricade was improved, and some assistance was also given to the Scots Guards in the construction of communication trenches. Sections returned to bivouac at 3.30 a.m.

After a day spent resting, so far as intermittent shell-fire would allow, in bivouac, the Sections again went forward at 6.30 p.m. to assist the 2nd Infantry Brigade to strengthen the defences of Gheluvelt. Each Section worked on a definite strong point. There was a good moon, and it was not difficult to site trenches fairly satisfactorily. Working strength of Sections being about 30 N.C.O.s and men, it was not possible to achieve a great deal, the work usually consisting of digging some six 15 ft. bays of fire-trench 3 ft. 6 in. deep, with as much protective wire entanglement as the material available would allow. Passages were also cut through the thick-set hedges surrounding the cottage gardens, to give free passage for the movement of troops. One good-sized garden had given place to what appeared to be two mine craters; these turned out to be shell holes from the enemy's new 13-in. howitzers, and the impression of this new form of frightfulness was somewhat distasteful. Sections returned to bivouac at 2 a.m. Again the Sections moved up to Gheluvelt at 6.30 for work with the 2nd Infantry Brigade of a similar nature, returning to bivouac at 2 a.m. on the 30th.

The 30th October was the day of the great German attack by Fabeck's newly arrived army group on the emaciated remains of the I Corps, 7th Division, and 7th Cavalry Brigade. The attack fell heavily on the two latter formations about Zandvoorde,* and at 1 p.m. the 23rd (Field) Company, R.E., was sent forward to join General Bulfin, who with two battalions of the 2nd Infantry Brigade was taking up a position along the southern edge of the Herenthage Château grounds. The 23rd (Field) Company arrived here about 3 p.m., and at once commenced to assist the Sussex and Northampton-

* *Military Operations in France and Belgium*, 1914, pp. 277–8.

shire by digging trenches along the edges of the wood. The work was slow, owing to the roots of the trees, cutting tools being required. The various Sections became detached, each doing whatever work could most assist the infantry companies they were with. The Sappers dug steadily until 9 or 10 p.m., whilst the woods nearby were heavily shelled. Three Sections collected about 11 p.m. under the O.C. and received orders to dig in and defend Groenenberg Farm. No. 2 Section, in the process of withdrawing on the completion of work, ran into General Bulfin, and was at once ordered to assist the 2nd Gordon Highlanders, who were taking up a position to the east of Groenenberg Farm. The battalion was discovered lying along a field track in an open, ploughed field on a slope falling gently towards the enemy, the officers and men dead-beat, and most of the latter fast asleep. It was apparent that, if no trenches were dug, little would be left of the battalion next day, but the men were obviously too done to dig at all. No. 2 Section therefore set to work, and the Sappers, who had already dug for seven hours, completed an excellent trench in the easy soil sufficient to hold 40 or 50 rifles, adjoining the wood on the left of the line; subsequently this section rejoined the others at Groenenberg Farm. The O.C., with Nos. 1, 3 and 4 Sections, were hard at it digging in round the farm, patrols being sent forward two or three hundred yards without finding any enemy. No. 2 Section was sent to thicken the Irish Guards' line to the west of Groenenberg Farm, where once more the Sappers commenced work on their fifth lot of trenches, in the light of a bright moon. However, about 3 a.m. on the 31st, two Companies of the Oxfordshire and Buckinghamshire Light Infantry arrived, and took over the defence of Groenenberg Farm, a very weary Field Company finding its way back to billets in the stables of Hooge Château.

The story of the great battle round Gheluvelt on the 31st is well known. At 10 a.m. the Company was ordered to move up to man trenches north-west of Veldhoek, but this, and a further message to the same effect at 11.45, were cancelled, and a commencement was made with a trench line on either side of the main road about what was afterwards Clapham Junction.

The position at and south of Gheluvelt was now becoming obscure, and at 1 p.m. the Company received orders to move forward on either side of the road to clear up the situation. No. 2 Section moved forward on the north of the road through the Veldhoek Château grounds to the Veldhoek cross-roads, where General Fitz Clarence (commanding 1st Guards Brigade) was encountered. He ordered this Section to dig in and prepare to defend a house and garden just north of the cross-roads. However, the great counter-attack of the Worcesters having restored the situation, this Section was unmolested, and suffered no casualties from the occasional shell-fire. Nos. 1, 3 and 4 Sections, under Captain Addison, struck further south, and had a

successful afternoon, turning some Germans out of a house, and rescuing a field-gun, of which the team had been knocked out by a shell. All four Sections returned to billets at Hooge Château at dark.

The following day, as a result of the catastrophe to the 1st and 2nd Division H.Q. at Hooge Château, the Section commenced the construction of a large cut and cover dug-out under the shelter of a house at the west end of Hooge, to act as a Divisional H.Q., and the work was continued on the two following days. The Company suffered a serious loss on the 1st November, a shell falling in the horse lines just outside the mounted men's billet in a farm. Several horses were killed, and six drivers hit, of whom two died later; billets were therefore moved to Rifle Farm, near Hellfire Corner, where they remained for the rest of the battle.

On the nights of 1st and 2nd, the Sections were employed wiring in front of the 1st Guards Brigade line at Veldhoek, and, as wire was now coming up fairly well, quite respectable entanglements were constructed. Each night, on the way forward, the Company officers looked in at Brigade H.Q.; an outstanding and happy memory of that strenuous and desperate time, when every visit to the front line found another good friend of the Aldershot days lost, was the wonderful atmosphere of confidence and good cheer ever to be found in that H.Q., sending us on to work feeling strengthened and refreshed at contact with so high and courageous a spirit.* Every officer and Sapper felt it a peculiar honour to work for such a Brigade.

On each of these days there was heavy fighting about Veldhoek, and each night the Sections went forward to wire the new front.

On the afternoon of the 3rd November, the C.R.E. reconnoitred the line, deciding on the position of a number of strong points to be constructed that night. For the first time, instead of the desperate hand-to-mouth patching up of the front line here and there, a considered scheme of supporting points was to be constructed, and to meet with its due reward.

Sketch No. 8A shows the details of the work carried out by three Sections of the 23rd (Field) Company under the O.C. on this night. These works were commenced and made good progress on the night of the 3rd/4th November, and continued on following nights. Work was also commenced on a dug-out for Brigade H.Q. at Fitz Clarence Farm. On the nights of the 5th and 6th, first one, and then two Sections were allotted to the 6th Cavalry Brigade south of the Menin road to improve communications through the Herenthage Château grounds.

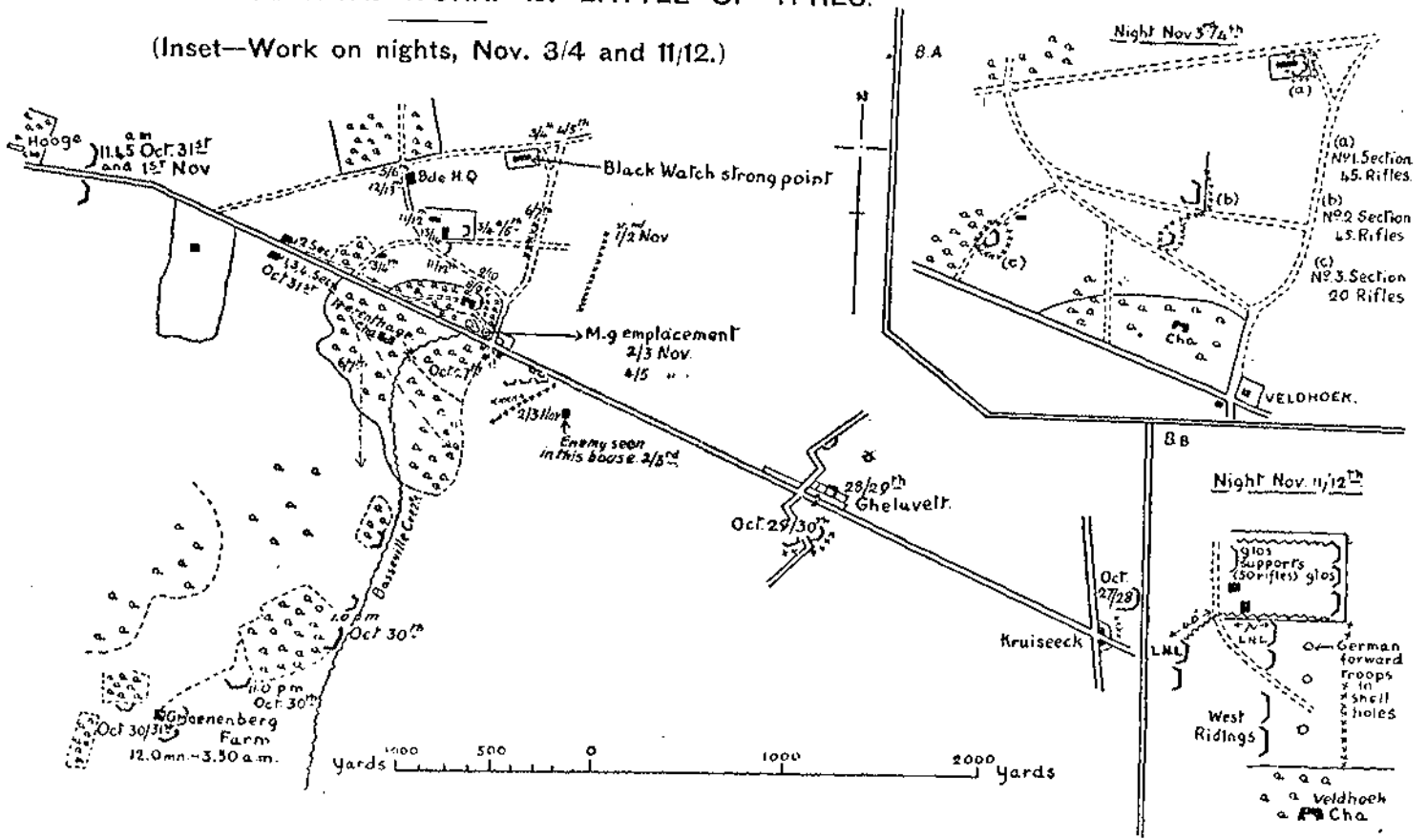
On November 4th, Captain Addison left the Company to become Adjutant, R.E., 1st Division.

* Brigadier-General Fitz Clarence, V.C., his Brigade-Major, Major (now Major-General) C. E. Corkran, and Staff Captain, Captain (now Colonel) A. F. A. N. Thorne.

Sketch No. 8.

SKETCH TO ILLUSTRATE WORK. 1st BATTLE OF YPRES.

(Inset—Work on nights, Nov. 3/4 and 11/12.)



On the night of the 7th November, the whole Company was ordered to Ypres, where hostile shelling had started more than one fire. The whole of one side of the main square was in a blaze, and it was obviously out of the question to do anything with that, but in two or three other places fires had barely commenced, and these were put out without serious difficulty. Just after midnight, it was noticed that a fire had started in the scaffolding round the Cathedral tower, which was under repair. Officers and men rapidly scaled the ladders to the topmost platform, where a sack of shavings was starting a fine blaze. Luckily the workmen had left behind a bucket half full of water, and with this, and the contents of waterbottles, the fire was soon extinguished.

The sight from the top of the tower was unforgettable. Far below, the blazing square, throwing into strong relief the, as yet, untouched Cloth Hall; all round the horizon, and as far as the eye could reach, the continual flash of guns, and intermittent brilliance of German Very lights, and from time to time, away in the direction of Menin, a tremendous flash, followed, after a long interval, by a deep and liquid note, rising to a roar, as a 12-inch shell plunged into the city below, making one feel as if the tower was about to be swept from beneath one's feet.

During the 8th, a Company of Zouaves, who had been holding a house just outside the Veldhoek Château grounds, were driven in, and the situation was somewhat uncertain. The whole Company moved up at night to dig and wire a new line through the grounds. Thanks to R.B.'s careful reconnaissance, and gift of extracting the last morsel of information from anyone on the spot, the Sections were saved from endeavouring to put up wire in front of a trench already occupied by the enemy. This work was continued on the 9th. Very large heavy loop-hole plates were utilized for the construction of machine-gun emplacements, but they seemed somewhat unwieldy. Overhead cover had also not yet died a natural death; we had still to learn that the earth parapet was the best defence against the H.E. shell.

On the night of the 10th, all four Sections were again at work with the 1st (Guards) Brigade, completing strong points and adding communication trenches.

The fruits of this work were abundant on the morrow, for the grand attack of the Prussian Guard, after piercing the thin front, was held up with the heaviest loss by the strong points, in particular that at Black Watch Corner, where the thick hedge had been well wired, and the whole prepared for all-round defence. Nevertheless, the situation was precarious, and the Company at one time, 2.55 p.m., was ordered to move forward to act as infantry, but was recalled a short time later.

At night, all Sections were employed on wiring and trench work in

the Château grounds, and in construction of communication trenches to improve a strong point occupied by the Gloucesters. A wire entanglement was also erected from the Gloucesters' strong point to the Château grounds.

On the following night, the Gloucesters, with great glee, informed the Company that, when morning broke, it was found that a number of the enemy had dug themselves in between the strong point and the Château grounds, and we had *wired behind them* in the rain and darkness. (Sketch 8B.)

During this day, heavy shelling of the back areas had taken place, and, amongst others, the Company horse lines had a severe time, several horses being killed. Nevertheless, Driver Bianchi, who had barely completed his recruit training in August, walked up and down, calming the frightened animals, adjusting footropes, and by his courage and devotion to duty undoubtedly saving more losses, and for his gallantry was awarded a well-earned D.C.M., the first honour in the unit.

On the 15th, no work was carried out, and orders were received for the 23rd (Field) Company to move at 11.30 p.m., and march to Vlamertinghe. An unfortunate catastrophe now occurred. The enemy by ill luck found the billet, dropped the first shell into the sleeping No. 3 Section, causing one fatal and eight severe casualties (rapidly and admirably dealt with by Captain Irvine, R.A.M.C., by the light of a stable lantern), and a second fell in the wagon lines killing several horses, including Stafford's delightful mare, "Lady." After this, the Company got under way, and it was with great thankfulness that Ypres was put behind, and, marching first to Vlamertinghe, then to Westoutre, and finally to Borre, came to rest at the hospitable farm of the Famille Oudinot.

On the march to Westoutre, an R.A.S.C. train wagon in charge of a very young and chubby officer was encountered, having skidded on the *pavé*, and stuck with its hind wheels in the mud. On the further side was a complete French Divisional staff in a column of cars, in the leading car a delightful white-haired old general, working himself into a state of purple fury at the obstruction. Our chubby friend, however, doing his best, beamed on the explosive old gentleman, and, in the most tactful manner, said: "Calmez-vous, monsieur, calmez-vous!"

(To be continued.)

WITH THE SHAFORCE, 1927

By LIEUT. E. S. de BRETT, R.E.

My job at Chatham was just at an end, and at 12.45 p.m. on Saturday, the 22nd of January, I had just completed discussing with the Adjutant the arrangements for my future. These being satisfactorily fixed, I proceeded to the Mess, feeling pleased with the world in general and my lot in particular. At 1 p.m. I received a War Office telegram instructing me to report at Eastern Command H. Q. immediately for service in China. In twenty-four hours I was out of Chatham, and in seven days was on board the *Kinfauns Castle* en route for Shanghai, in company with those of the Staff who had not gone on ahead on the *Megantic*, Major Witts, McCandlish, Wilson, the H. Q. personnel, and the 2nd Bn. of the Coldstream Guards. This was a fairly sudden departure, but could not be compared for speed with the rapidity with which some people had to get on the move.

We had an enthusiastic send-off, both from Waterloo and Southampton, where the proceedings were further enlivened by the successful effort at desertion of a drunken stoker, who dived overboard at the last minute, and evaded all efforts at recapture till the ship was well under way. My last impression of Southampton was of a line of people with hands linked, singing "Auld Lang Syne," and of a bedraggled stoker shaking hands with himself, and dancing unsteadily on a raft.

The voyage was uneventful save for the weather in the Bay of Biscay, where we struck the tail end of the storm which drove the *Assaye* to shelter. We made very good time, arriving in Hong Kong harbour thirty-one days after leaving Southampton; our only stops were at Port Said, for ten hours; at Colombo, where the troops went ashore for a route march, for twenty hours; and at Singapore, for one hour, to put off a sick man. We spent much of our time in speculation as to whether we should ever reach Shanghai, and if we did, what we should do when we got there. I may say that what we had to do exceeded our wildest flights of fancy. We had lectures on China and the Chinese; we read books on China, and we tried to keep pace with the Chinese situation by studying the scanty bulletins. Everyone in the ship was in the frame of mind when they were ready to believe anything, and the entire staff leaped from their bunks early one morning to read the amazing news that Shanghai had been looted, only to find, on reaching the end, that the whole thing was an

elaborate and skilfully worded hoax. We were wakened in the morning by the stamping of P.T. shoes, we wrote our letters to the accompaniment of rattling machine and Lewis guns, and we were lulled to sleep after tiffin to the strains of at least two schools of "house." To these tortures were added those of the doctors, with their pills, vaccines and inoculations, which were, administered at intervals, calculated to keep us from feeling entirely fit for the whole voyage. In spite of all these horrors we were a very happy ship, and the time passed pleasantly enough.

Arrived at Hong Kong, we were greeted with the news that McCandlish and Wilson were to help the harassed R.E. Staff there, while Major Witts and I were to proceed by the first available ship for Shanghai. The feelings of all concerned are perhaps better left to the imagination. After four days of maddening delay at Hong Kong, we changed into the *Karmala*, and went up to Shanghai with half the Armoured Car Company, those of the Staff who had not been kept at Hong Kong, and a portion of the H.Q. personnel.

We tied up at the quayside on a cold, wet afternoon, on the 8th of March, and started to unload stores at once, to the accompaniment of the "Ah—Ha, Oh—Ho" of the coolies. That evening and the next day were spent in getting the troops into quarters, and my first job was to go off and inspect the billets destined for the H.Q. personnel.

I will now try to give an impression of Shanghai from the billeting point of view. The city (by which I mean the International Concession) stretches for some ten miles along the North bank of the River Whang Poo, and is about three miles deep on an average. The river is half-a-mile wide, very swift-running, and presents the most cosmopolitan selection of shipping. In connection with this, a knotty problem arose when the Ensign was hoisted on the flagship, H.M.S. *Hawkins*. It is the custom to play the National Anthem, followed by those of all other nations in port, in order of seniority of their commanders. In this case there were no less than eight, and it was decided to cut short the entertainment and play one a day in rotation.

The settlement itself is a network of streets, of which the main thoroughfares are wide and well kept, and on to which face the large business houses and the better-class residences. The spaces between these main arteries are filled with a maze of narrow, evil-smelling, filthy alley-ways, and a jumble of ramshackle houses. Towards the outskirts of the settlement is the residential area, which stretches beyond the settlement boundary westward for five miles along the municipal roads. What available open spaces there are in the settlement are unsuitable for tents, being low-lying and under water in wet weather, filling and drainage being necessary before any building can be undertaken. The sanitary arrangements, except in the most modern houses, are of a primitive nature, and the Chinese ideas of hygiene not conducive to taking advantage of what amenities

are available. These disadvantages are almost set off by the excellence of the municipal water and electric supplies.

Into this over-crowded city were poured 16,000 British troops alone in the space of two months, from the middle of February to the middle of April. All these had to be adequately housed, with sanitary and cooking arrangements to combat the hot weather and its attendant ills. The former was supposed to begin at the end of May, but fortune favoured us in this year of topsy-turvy seasons by postponing it till the last week in June. Owing to the unceasing efforts of the doctors, the latter did not take such a heavy toll as had been anticipated up to the end of July, when I left for home.

Colonel James, Dykes, and two foremen of works arrived on the 26th February with the first instalment of the Staff, to find the Public Works Department, and the Billeting Committee, under Colonel Logan, hard at work taking up buildings and erecting huts, in a gallant endeavour to meet the coming influx of troops. Their help was gratefully accepted, as we were without knowledge of available properties, and their advice, without which we should have been in sorry straits, was of inestimable value.

To detail the arrangements for the billeting of the troops is a task better left to the official pen, and it is enough to say here that they were quartered in mat-shed huts with wood floors, unlined wooden huts, cold, cheerless "godowns," stables, and dirty Chinese houses. The weather was cold and wet; being in a city, it was not possible in the majority of cases to make even field sanitary arrangements; the troops in the line were soaked daily, and were not able to dry their clothes; there was nowhere for them to play games, except the Race Course, which was miles away from any unit not actually billeted there; they had every discomfort imaginable; all of which would have been far easier to bear had there been any chance of a fight. The orders were that no shot was to be fired save in extremity. Add to these drawbacks every opportunity and encouragement from outside to get into trouble, and you have some idea of the strain put on the moral fibre of Thomas Atkins. All these things were patiently endured and steadily bettered; but the first two months of war under peace conditions (or *vice versa*) was a period which stretched the tempers of everyone very nearly to their limit.

Force H.Q. were at Ewo Terrace, where the C.R.E., S.O.R.E., and two A.E.'s worked in one room, with one telephone, and our massive staff of two clerks and a draughtsman in a room downstairs with no means of communication; a defect which was speedily remedied. We had brought twelve motor-cycles with us, and, being Triumphs, they lived up to their reputation by being our trusty companions during the whole of the early period. We were later promoted to cars, when the danger to the life and limb of scarce and hence valuable

members of the R.E. staff had been amply demonstrated by a number of smashes of varying intensity.

A word as to the Chinese traffic mentality may help to illustrate the dangers of riding and driving in Shanghai. All the motor-cars in China live in Shanghai, and are driven by Chinese, whose one idea is that if the horn is screaming they are safe. The speed of the traffic would scare the most daring thruster at home, and the control is in the hands of Chinese and Sikhs, who, to give them their due, are remarkably efficient; but they are powerless to control the pedestrian whose main idea is to cut as close as possible to the front of a rapidly-moving vehicle, in order that the devil, who is in constant attendance, may be caught unawares, run over, killed, and so disposed of for the day. A Chinese on a bicycle never steers a straight course, for that would make it far too easy for the pursuing devil. In addition to these, there are the usual dangers of wet and slippery streets, tram lines, and that perpetual menace to motoring—the man who will never make the correct signal.

Our immediate problem was to set to work and make the troops as comfortable as possible for the moment. We procured excellent maps from the Intelligence Staff, and on them marked the unit H.Q. Armed with these and a notebook and pencil, we set off on motor-bikes to explore the town.

Our normal day's work was somewhat as follows:—

8.30 a.m. to 9.15 a.m. Telephone.

9.15 a.m. to 1 p.m. A hectic rush from point to point on a motor-bike, instructing contractors, haggling over prices, telling them to "do it again," going into unit orderly rooms, and being seized upon by the Adjutant, the Quartermaster, the Medical Officer, and all the company commanders in turn; these all badgered us for everything, from "We simply must have another light in here, my clerks cannot see a word at night," to "When are you going to build a new kitchen, dining-room, bath-house, and canteen." We wrote everything politely in our little black books, with a pious expression of hope that they would all be put in hand at once, and then went off to try and make some order of priority which was apt to be lost sight of by the people concerned. Then came tiffin, after which we were again a mixture of commercial traveller, foreman of works, bargain-driver, fairy godmother and newsagent—it was firmly believed that the entire staff confided to us all their dispositions; at least, that was the impression that we got from the numerous and baffling questions that were hurled at us wherever we went. Tea and business could usually be combined with someone who wanted something.

8 p.m. Dinner, and a short respite, after which we sat down to study our little black books, which had become quite a by-word From them we wrote out orders on contractors, made out schemes, struck out the unessential (making a mental note of something not

too rude to tell the mutt who had asked for the moon) and arranged our next day's programme.

It may be asked at this point why we did all these things ourselves; the answer is that we had two clerks, who had all they could do to keep pace with the C.R.E.'s correspondence, and five foremen of works, who had just completed their course at Chatham, and were fully occupied in trying to keep pace with the work in hand. At this period, the settlement was divided into two halves by the Soochow Creek, Dykes being A.E. East, and I, A.E. West.

During the first six weeks, the 10th H.Q., Madras Sappers and Miners, were hard at work helping to make the line more tenable and comfortable. The problem of wiring the settlement was complicated by the fact that the Chinese houses on the boundary roads all had a back entrance on to the Chinese city of Chapei. There was much wailing from shopkeepers in the centre of a long stretch of wire that their trade was being taken away from them by those more favourably situated. Posts were built at points all along the line, and eventually assumed the most complicated designs. At one place they constructed a concrete pill-box which came to be known as the tower of Babel, because it was built by Madras S. and M., under British supervision, for the Japanese; the traffic was controlled by Sikhs, and the crowd kept on the move by Chinese Police.

The S. and M. had the unenviable task of issuing R.E. stores and materials; for weeks afterwards they were chasing picks, shovels, and tools, to which units innocently swore ignorance. Later, when the defences had been completed, they turned their attention to the construction of movable concrete and steel pill-boxes; they also carried out the first experiments in hut raising; as a grand finale, six huts were carried in sections down Broadway during the heaviest traffic of the day.

The state of emergency was declared on the 21st March, and we all donned revolvers and tin hats, which were an added burden to us on our motor-bikes. The following day, McCandlish, Wilson, and two more foremen of works arrived on board the *Bellerophon*. The former took on the job of A.E. West 1, while I gracefully retired to the position of A.E. West 2; the latter went to help Dykes as A.E. East 2. He was later installed in an office by himself, under the title of A.E. Central, and worked the central district and the Pootung side. That was done in anticipation of two more subalterns, who were reputed to have sailed from England. The sites of most of the new camps were necessarily towards the outskirts of the settlement, and therefore fell to the lot of either A.E. East or West. As their work became heavier, so A.E. Central expanded, and relieved them of their more central billets.

Temporary accommodation having been completed, we took a deep breath and plunged into the problem of permanent accommoda-

tion on a scale to suit the doctors; mat-sheds and forty men in a 70 ft. by 20 ft. hut, with the hot weather and flies only six weeks away, put them in a terrible state of agitation. Followed a period of house hunting by the Billeting Committee, frequent shuffling of units by the Staff, and feverish planning of camps and alterations to buildings by ourselves.

We had now reached the stage where it was possible to apply the principles of plan, specification, estimate, and contract, as the need for economy overcame the necessity for speed. The P.W.D. gave us their list of contractors and their schedule of prices, found us some Chinese draughtsmen, and we started to get tenders for everything that was not required by the next day. Their schedule was of some assistance in giving us an idea of prices, which were all over the place. As an example of this, I will quote my experience with iron hooks for equipment. I called for tenders, and duly accepted the lowest for fifteen Tael cents apiece, a price which was considered high but not absolutely unreasonable. After about six weeks, Dykes called again, as the first supply had run out, and he got the same thing for six Tael cents; it took a long time to live that down. We tried later to get contractors to accept the Hong Kong schedule for all kinds of work with a fixed variation, but they said that prices were fluctuating too much to allow them to take the risk. Everything had, therefore, to be done by tender, and, later, we began to build up an abbreviated form of schedule by making running contracts for all kinds of repair and maintenance work.

A word as to the Chinese contractor, his estimating, morals, organization, and honour, may give some idea of a few more of our problems. The contractor with whom one deals is probably a financier, who sublets a large order to a number of smaller jobbing contractors. He is, of course, responsible that the work is satisfactorily carried out, and to that end we always stipulated that his "No. 1 Man" on the job should be able to speak English. He was rather shy at coming forward at first, but when he saw that we meant to pay he rushed to share in the spoils.

We had some trouble with upstarts at the beginning, but we soon got to know them, and settled down to the best men.

His estimating is on the hit-or-miss principle, and bills of quantities are unknown even on the largest works. In our case, we had some astonishingly diverse answers to our calls for estimates, as they all had to be returned in the shortest time possible, and it was very often difficult for a ring to be formed. Sometimes a surprisingly low price could be obtained by asking for an estimate "while you wait," but our usual method was to take the lowest price, and then haggle with the contractor.

The Chinese are born gamblers, and are always ready to toss for it: so that, if one's idea of a price did not agree with the con-

tractor's, a reduction could frequently be effected by an appeal to this sporting instinct.

Once a price has been fixed, there is no getting out of it, even if the contractor has missed a point in the agreement, as he frequently did. Often he would turn up unexpectedly in the evening, to try and get the lowest price for a certain job, or bring presents for no apparent reason; in the latter case, one would look for something going wrong the next day, and one was very rarely disappointed. He could never grasp our reasons for refusing his presents and invitations to dinner, and regarded us as quite mad for not taking what to them is legitimate *cumshaw*. He does not try to get away with large evasions, but tries a number of small ones to achieve the same effect. These gave us endless trouble by having to get things done again.

The "chink" is good in the matter of organizing his work; all the hutted camps were built on the mass-production principle, and, once he had got the hang of anything, he turned it out at the most amazing speed. Materials arrived in the right order and in plenty of time to keep the job moving, and I never saw work held up for want of men or materials, save in the case of mud filling (of which more anon). The only factor which seriously held up the work was the rain. "Belly wet day, no man can come." This led to much argument as to the number of rain days, when deciding the date of final completion of any work.

They are gifted with a very considerable sense of humour, and solemnly assured us that there was plenty "cry-cry in the tea shops," as we were so strict in enforcing our conditions as to the quality of materials used. There is an old story of a foreigner, who thought that he was getting the better of a Chinese, who had got the contract to build a new kitchen for him. He told his Chinese tutor of his deal, and the latter said, "You think you make plenty cheap job to pay Wong $200. I tell you he sublet to Kong for $100, and he sublet to Fong for $10, and he make 100% profit."

One in particular was a most cheery rascal, who had been producing very poor timber for some time, so that we had had to take vigorous measures. He came to me one day and said, "Sir, perhaps more better I fix timber tempolally, then suppose you say it no belong ploper fashion, I take it away. Bye and bye I build myself a new house and use the wood you no like."

This return to orthodox methods produced its crop of paper, and we were soon up to our ears in estimates, specifications, contracts and bills. About this time, also, the unit orderly rooms had begun to get busy, and the clerks to get regular exercise, which flooded us with a mass of correspondence, the chief subject of which was:—

"The following points were noted by the M.O. on his inspection on the —th. May they please receive immediate attention."

These we treated in a somewhat cavalier manner, sending them back

with a pencilled reply on the bottom. The result, of course, was that when a reminder arrived, which was always the case if the job had not been completed within 48 hours, starting "With reference to my ———, dated ———," we had nothing filed for reference, and so the reminder was sent back with "This matter is in hand" written on the bottom. This reply was nearly always true, as we kept all these small jobs written in our little black books, and worked them off as quickly as possible. When we eventually did get a clerk, on 30th May, it took us some time to get out of bad habits, and write proper replies.

All this rapid ordering of work produced its corresponding flood of bills, which had to be checked and paid; we got to the stage when we simply dreamed of bills. We managed to educate the contractors to sending their bills in in duplicate, which saved the clerks much time and trouble, but we could never get them to realize the time it took to effect a final payment. Most firms have a *compradore*, who handles the cash, and when a contractor sends in a bill he receives a *compradore* order for 75%, which he cashes straight away. Our machinery for checking and signing was quite beyond his comprehension, and up to the time I left I think he still believed it was some subtle method for avoiding payment, and regarded it with the deepest suspicion.

The Chinese Dragon Boat Festival fell on the 4th of June, just as this flood of bills was at its height; this, and the Chinese New Year, are the two great settling days, with the result that we were besieged by contractors all clamouring for payment, and the combination nearly drove us crazy.

I must break away here to say a word about the King's Birthday Parade and the Torchlight Tattoo, both of which were held on the Race Course, where there was plenty of space, and excellent accommodation for the spectators. The 2nd Battalion of the Coldstream Guards performed the ceremony of the Trooping of the Colour in a manner which fully upheld their high reputation. After this came a march past by detachments from every British unit in Shanghai, including the Shanghai Scottish and the Sikh Police. The whole performance was very impressive, and served to give a good impression of the large number of British troops in the settlement.

The Torchlight Tattoo was exceedingly well staged, and did much to raise British prestige in Shanghai. The majority of the spectators had never seen anything of the kind before, and the applause with which it was received, both in the stands and the local Press, was ample testimony to the feeling that it evoked. The Americans were particularly appreciative of the marching and counter-marching of the massed bands at each function. One was overheard to remark, "Say, if our boys started in on that dope it would take the whole of the New York police a week to get them sorted."

The types of work with which we had to cope were varied; they included barrack accommodation, hospitals, ordnance depots, aerodromes, mechanical workshops, and bakeries. These all had to be fitted into huts, or ready-made buildings, whose designers had no more idea of them being turned into anything else than flying over the moon. In many cases, the buildings were old and dilapidated, and had been condemned to be pulled down. In every case we had to alter and amplify the cooking, sanitary and lighting arrangements; in the crowded part we were reduced in several cases to building kitchens, and in one notable case, a bath-house and battery of flush latrines on the roof.

The aerodromes were magnificent mat-sheds, 70 feet by 80 feet by 17 feet high to the eaves, about whose construction we had serious doubts. These were fully justified when one of them collapsed, after a ditch for laying fire hydrant pipes had been dug, while our backs were turned, exposing the feet of all the side struts, which play a very large part in the stability of these structures. Fortunately, owing to the vigilance and intelligence of the foreman on the job, there were no machines in it at the time, and no further accidents occurred, though it was the subject of a very good leg-pull on the A.E. concerned!

In nearly every case the sites taken for camps had to be raised, and our transactions in mud assumed immense proportions. These operations were very hard to keep checked, as all mud and ash coolies are trained (or appear to be) in the art of juggling mud from a measured heap to one about to be measured. Contractors would never take the measurement of the hole and give a price for doing the job, but always insisted on measuring the mud at the side, and then throwing it in, a procedure which gave us endless trouble. They also hollowed the tops of the heaps, and dug little trenches round the bottoms; the haggling and arguing that ensued nearly turned our hair grey. In two cases, huts were built on ponds that we had drained and filled, and we had pile-driving operations, which were very amusing to watch. They consisted in erecting a staging on which a gang of coolies stood in a circle; each coolie had a rope attached to the collar of a 225-pound monkey, which they heaved up and down to a chanty rather reminiscent of the Volga Boatmen.

The permanent wooden huts were built on concrete footings, raising all timbers from the ground; they were made with vertical T and G boarding on studding, and lined with wall boarding of various sorts—we bought all there was in Shanghai, and sent abroad for more; they were ventilated by means of louvres along the roof and over the windows, and were fitted with fans and electric light. A large consignment of wall-board went astray, and did not arrive till after the hot weather had begun, and so we were reduced to expedients for lining. In one case, we used Chinese plaster, which

was put on at a great speed, and made a very nice-looking job when it was done. In another case, we used three-ply ash, in great fear and trepidation, fully expecting it to disintegrate at the end of the hot weather.

All the timber was very unseasoned, and the shrinkage that took place on a dry day was enormous, and we had great difficulty in inducing contractors to produce even the best that was to be obtained. The local civilians said that we were too rigid in expecting exact compliance to our standards, but we persisted in our "armed" inspections, and in the end got better material than we had thought possible at the beginning. Our "arms" consisted of a stout chopper, with which we destroyed undesirable timber, a proceeding which was very good for discipline, as well as the quality of the timber.

The drainage of the sites was rather a problem, owing to the difficulty of getting a good fall. We only attempted to cater for the steady rain, as, when it really made up its mind to rain, all the creeks and main drains backed up, and everything was flooded for some hours, till the waters had subsided.

Hot-water schemes, electric light, and cooking arrangements had, of course, to be thought out in every case, and in connection with the latter a rather amusing situation arose. We had discovered a very satisfactory and cheap type of kitchen range, made in various sizes, exactly suited to our needs, which we installed in a number of billets. One of the A.E.'s thought that this firm was getting too much of the benefit of our patronage, and hunted about for another type equally suited to our requirements; he eventually found one, and proceeded to install it in some new billets, only to find, after they had been installed, that they were manufactured at the same foundry as the previous one.

All these serious problems were eventually solved, and everyone was made fairly comfortable. Our existence, though strenuous, was relieved by such merry interludes as turning out the Municipal Fire Brigade to reeve the G.O.C.'s flagstaff halyard, which had come unreeved during a gale. I was at my wit's end for a scheme avoiding the use of climbing irons, or taking the pole down, and there were no ladders long enough, when some bright spark suggested the Fire Brigade, and the ceremony was performed with much speed and dispatch before a large and interested crowd, who had collected expecting to see a grand conflagration.

WORKS DIRECTORATE.

A Lecture delivered by LIEUT.-COLONEL D. K. EDGAR, D.S.O., *at the Staff College, Quetta.*

I HAVE been asked to speak upon the organization and working of the Works Directorate on the Lines of Communication, and will try to make my remarks applicable to any country beyond the Frontiers of India, illustrated by episodes which came under my personal observation in Mesopotamia.

Before beginning, the scope of the work to be undertaken in a barren country should be realized, as for purposes of engineering all the countries beyond India are barren, inasmuch as the majority of material and personnel for engineering works has to be imported.

According to *Field Service Regulations*, the Director of Works is responsible for the provision, construction and maintenance of buildings, offices, stores, camping grounds, roads, etc., provision of water supply, gas, electric lighting, or other technical plant required for military purposes on the Lines of Communication, and not provided by other Services. The last sentence is open to a very wide interpretation, and means that the Works Directorate must be prepared to tackle any job, which other Services will not undertake.

In order to carry out these many duties, the Directorate should be divided into the following sections :—(*a*) Electrical and Mechanical. (*b*) Engineer Stores. (*c*) Roads and Buildings.

If the road construction represents a heavy item, it might be well to place it in a separate section. Each of these sections would be under an Assistant Director or Deputy Director of Works, and the work of all of them co-ordinated by the Director.

In order that the Director may arrange for sufficient materials and personnel to carry out the works entrusted to him, it is essential that he should be fully acquainted with the general idea of the campaign, know the number of troops and hospitals, etc., for whom accommodation has to be provided, the class or standard of construction to be maintained, and the places at which the accommodation will be required. Very often the latter point will be decided by engineering requirements, such as an available water supply, suitable sites for building and ease of communication, more than on tactical requirements. It is better for the Staff to decide on the District in which it is desired to locate a Cantonment, leaving the recommendations for the actual site to be made by the Engineers.

One point that should be borne in mind when laying out canton-

ments is the necessity to allow for expansion ; and this is especially important for store areas. The areas allotted for stores should be generous in the first instance, and should be capable of expansion in one or two directions. Cramped storage space makes the handling of stores difficult, increases the danger from fire, and makes the work of checking and accounting for stores much more arduous.

Any change of policy should be communicated as early as possible to the Director of Works, in order that provision may be made for additional requirements. One of the first duties of the Director is to draw up War Establishments for the various sections of his Directorate, and these should be capable of rapid extension, if necessary, to meet the needs of the Force. In Mesopotamia, during 1916 and 1917, this expansion was so rapid that in some instances before sanction had been received to a Revised War Establishment, it had been necessary to revise it again, the delay in sanctioning being due to the fact that it had to be submitted to Army Headquarters, India.

The programme of construction would have suffered considerably owing to this delay, if the D.A.G. 3rd Echelon had not acted on the assumption that the Revised War Establishment would be sanctioned, and demanded reinforcements on the new scale in anticipation.

War Establishment for Works should also be capable of small adjustments without revision. For instance, in the E. and M. Section during the period of erection of plant a different class of workmen will be required, from when the machinery is erected and running. This difficulty was overcome in Mesopotamia by entering the majority of skilled workmen on the War Establishment for the E. and M. Section under the one general category of artificers. This allowed the A.D.W. E and M. to vary his trade categories in his monthly demand for reinforcements to meet his ever-changing requirements, without revising his War Establishment.

For the Engineer Field Parks, three distinct classes of personnel have to be provided. (*a*) Store Clerks. (*b*) Coolies for handling stores. (*c*) *Chowkidars*.

The latter item has to be included if it is desired to relieve troops of the duties of guarding stores. Some means of protection for stores has to be devised, and in many cases *chowkidars* are quite as efficient as troops. Coolies for handling stores could be provided from Porter Corps, but this has disadvantages, unless a Corps or portion of a Corps is placed permanently at the disposal of the A.D.W. Parks, and not changed. The reason for this is obvious, if it is realized that engineer stores usually arrive in bulky, heavy and awkward packages, which it requires special training to handle expeditiously. There is a great difference between handling a bale of *bhoosa* and the fly-wheel of an engine, or between a case of condensed milk and a rolled steel joist.

Great difficulty was experienced in Mesopotamia at times on this account. Local Arabs were lazy and inefficient, the average weight

of stores moved by them was ¼-ton per day. In 1916, the congestion was so bad that General Stokes-Roberts, Director of Works, arranged with an Indian Labour Contractor to bring out 250 stevedores from Karachi on a year's contract. This method of securing labour was only resorted to when other legitimate means failed, and Government of India orders came that it was not to be repeated. However, for a year the handling of stores went on smoothly at the Base Park, Basra. At the end of the year, a part of a Labour Corps was placed at the disposal of the A.D.W. Park, and, commencing at ½-ton per day per man, the average weight of stores handled eventually reached 1¼ tons per day, due to training and organization. On the departure of this Corps, the average dropped, until the new Corps became trained in their duties, which took about three months.

While on the subject of Labour Corps, I may mention that many controversies raged round them on the matter of their administration, control and responsibility. When the first two or three Labour Corps arrived in Mesopotamia, they were Engineer Corps officered by R.E. officers, and containing a large number of skilled artisans. It was possible to give the O.C. charge of a definite area and all engineering works were carried out by him. Later on, when the number of the Corps increased, it was not possible to provide sufficient technical officers, and the Labour Corps became less skilled. The usual procedure became to make a Works Officer responsible for the work, with a Labour Corps to carry out his instructions. The administration of a large number of Labour Corps became very onerous, and a Labour Directorate was formed for the administration of all Labour and Porter Corps, and also the control of local labour. This resulted in economy with regard to the administration and distribution of labour, but when the Director of Labour also wanted to take the responsibility for all works carried out by his Corps, including Engineering Works, there was a difference of opinion.

The Director of Works is the responsible head for works entrusted to him, and the chain of responsibility must run through the officers under him, and cannot be delegated to another Directorate.

The large amount of technical labour required in the " Roads and Building " Section of the Works Directorate was supplied by Works companies. The strength of these companies was roughly 1,000 men, and for the most part consisted of skilled artisans, with a Headquarter Section for administration. The O.C. was in some cases a Technical Officer, but as his whole time, and that of his Adjutant, was spent in administrative work, technical engineering knowledge was not essential, the personnel being detailed as required to the Works Officers in charge of actual works. There were a good many jobs in the Works Directorate which could be run by non-technical officers, in connection with personnel and stores, and this should be borne in mind if there is a shortage of Technical Officers. In Mesopotamia we had

a clergyman, who had joined the I.A.R.O., a law student, and many others, who did good work on special jobs.

The question of the supply of tools is an important one, second only to the supply of material, as men cannot be employed without tools.

The reserve of tools should be ample, as unfortunately on service the wastage is great, but this wastage can be reduced if the O.C's. Works Companies and Labour Corps maintain tools and plants ledgers for their units.

Take a Labour Corps, for instance; they may be employed on hutting or road-making, or preparing a defensive position in the rear of the army, or other works. Different tools will be required for each job, and it would not be economical for a Corps to maintain all tools which it may possibly require on every occasion. Each Corps should have on its own ledger sufficient tools to enable it to look after itself, and prepare its own encampments and temporary hutting; and they should be allowed to make themselves as comfortable as circumstances permit, for ill-fed and ill-housed men cannot do a fair day's work, and greater efficiency will result if a proportion of the men are detailed for camp work, until everything is ship-shape. The balance of tools for the work in hand should be drawn from the nearest source of supply, and kept on a separate loan ledger. On completion of the work, surplus tools should be returned to store, to be utilized again by other Corps if necessary.

One Corps in Mesopotamia, while at work at the Base, was issued with a circular saw. On being ordered up river for some irrigation work, the O.C. tried to take this saw with him, as he thought it might be useful to him again some day. This was the non-co-operative spirit, but fortunately his designs were discovered, and the power saw and many other useful tools were removed from his possession, and he departed only with the essential tools for the work he was about to undertake. The spirit of co-operation in many cases is noticeable by its absence. Some units go on the principle of everyone for himself, and the devil take the hindermost. They usually manage to make themselves most comfortable by purloining material, etc., and building themselves luxuries, while the more essential services suffer. The R.E. officer alone cannot prevent this, and it requires the assistance of the Staff. There is a great difference between some units, who assist the R.E. in their works and do things for themselves, and others, who obtain unauthorized things by subterfuge. One unit in an outlying part of Basra, on being ordered to Bagdad, proceeded to dismantle their huts and pack the material on a barge, with the intention of re-erecting them at Bagdad. This was not discovered until after they had left, and it took several days to get the barge back and the material unloaded, after which the huts had to be re-erected for another unit. I might add that the delinquent was an R.E. unit.

Some officers have the knack of getting more work out of men than others; this is partly due to tact, but I think that the proper organization of working parties has more to do with it. If every man does a full day's work, it is extraordinary what can be accomplished by 1,000 men. Where possible, each man or gang of men should be given a set task, and allowed to return to camp on completion of it. The tasks can gradually be increased as men become accustomed to the work. Owing to the fact that men are engaged on a monthly rate of pay, it is difficult to pay them by piece work, but this can be overcome by offering a bonus or overtime for extra work beyond their set tasks.

If men are slack and lazy, some punishment must be devised to fit the crime, and this is where a good O.C. proves his value. A combination of a deterrent to slackness and an inducement to work produces the best result. It is not always possible to give men set tasks, but with a little ingenuity some species of task work can usually be devised. Men who are doing hard manual labour require rest days. One day in seven is sufficient, but whether the whole Corps should be rested for one day a week or 15% of the men allowed off every day depends on circumstances. The men enjoy the rest better if all are together, and it also gives an opportunity to the officers and supervising staff to rest if the whole work is stopped for a day, but the stoppage of the work may interfere with other Departments, in which case it will be necessary to lay off a proportion of men each day, and allow the work to carry on continuously.

Reinforcements for technical personnel is a difficult matter, and received a great deal of attention in India, especially during the latter part of the War, when labour was becoming scarce. The early organization in India was not capable of dealing efficiently with the great demand for labour which took place in 1916. Men arrived at Basra without nominal rolls or identity discs, and it was impossible to say for whom they were intended, and after arrival a great deal of work was thrown on the O.C. unit, to which they were eventually attached, in the preparation of their papers. I remember one instance of the arrival of 150 Chinese carpenters, who were booked as Chinese carpenters for the Works Directorate, but were not in possession of any of the necessary papers. The O.C. Works Company tried to prepare the nominal roll, showing next-of-kin, and to issue identity discs, but as many of the men possessed the same name, and all gave as their next-of-kin their uncle Foo Sing, who was the agent who engaged them, it was difficult to identify them. In addition to this, they appeared to attach a monetary value to their identity discs, and would gamble with them, and after a lucky night one man might be in possession of several discs, none being his own. After several weeks, the O.C. Works Company produced some sort of order out of

chaos, but I am certain that many Chinamen who died were reported under wrong names.

Before reinforcements are dispatched from India to the Base, each party should be in possession of several copies of a nominal roll, showing their number, name, next of kin, trade category, depot in India, and for whom intended ; a copy also being sent by post to the Directorate concerned, showing date of dispatch, and name of ship. With regard to the identification number, each Directorate should have a distinguishing letter prefixed to the number. For instance, carpenters were required for the Works Directorate, Ordnance, I.W.T., M.T., Railways, and others. The letters W.D., O., I.W.T., M.T., etc., were placed before their number, and there was no possibility of the men being posted to the wrong Directorate. If, during their term of service, they were transferred from one Directorate to another, they were allotted new numbers, and the change published in Part II orders, copies of which were sent to all concerned in India. In order to avoid duplication of numbers, it was arranged with India that a certain block of numbers, say from W.D. 5,000 to W.D. 10,000, should be reserved for use in Mesopotamia, and not allocated by depots in India.

At the Base, a depot should be formed to receive the reinforcements, and distribute them to their Directorates. In case any Directorate is large enough to warrant a separate depot, this should be formed under the Director concerned. In Mesopotamia, all the large Directorates had their own depots for the arrival and dispatch of personnel, those for miscellaneous units going to a central Followers' depot.

A great many complaints were registered in Mesopotamia regarding the class of artisans sent out. It is most difficult for the recruiting officer to know whether a man is a fitter, as he claims to be, or only a fitter coolie. A system of trade tests is the only means, as a rule, for ascertaining a man's capability, and even this then is open to abuse by impersonation. However, special cases can be dealt with by special means. Towards the end of 1916, when a large electric installation of 750 kw. had to be erected in Basra before the hot weather of 1917, and it was necessary to obtain a large number of skilled and efficient personnel for the work, permission was obtained to send an officer from Mesopotamia on recruiting duty in India, who knew where the labour could be obtained, and who picked his men personally. The results were eminently satisfactory.

The personnel sent on service should be the best possible available ; they should be dispatched expeditiously, and once they have left their depot should be got on to their work in the least possible time. These men have to be paid and fed whether they are working or not, and unnecessary delay causes loss to the State. On arrival at the Base Depot, if all papers are in order, 24 hours should be sufficient

to check, muster, issue tools and extra clothing if necessary, and to dispatch on to the works.

To enable the dispatch of reinforcements to be carried out expeditiously and efficiently, there must be a sound organization from the recruiting depot to the Base depot; any weak link when delays occur will cause loss to the State and inconvenience to those expecting the reinforcements.

With regard to the rates of pay of this civilian labour, unless some control is exercised, Directorates will vie with each other to obtain the best labour, and offer better and better terms, causing enormous rises in the price of labour. It is for the recruiting authorities to decide the minimum rates of pay at which labour can be obtained, and a schedule of wages should be laid down. In preparing this schedule, it should be recognized that all men of the same trade are not of equal value to the State, as there are many grades of workmanship. To overcome this difficulty, each trade category should be divided into grades 1st, 2nd and 3rd, if necessary, with a sliding scale of wages. If there is a large number of recruiting centres, it is most unlikely that the grading of men will be equitable, and, when on service, this will cause dissatisfaction where superior men are working alongside of inferior ones, and the latter drawing more pay. For this reason, Directors should be empowered to promote men from one grade to another, or from one category to a higher one; instance, a 1st-grade carpenter might be promoted to be a 2nd-grade carpenter *mistry*. This will also give men an incentive to work well, if they know there is a chance of promotion. Similarly, bad workmen should be reduced in grade. Under the agreement in force in Mesopotamia, this was a difficult matter to carry out, and a clause should be entered in the agreement empowering the Director to make such reductions.

In Mesopotamia, it was found that the only way to reduce a man was to give him the option of accepting a lower rate of pay or being returned to India as incapable. When the expense of recruiting and transportation is considered, it is most undesirable to return men to India after a few weeks' service, but it is equally undesirable to have incompetent men drawing high rates of pay. Clauses should be embodied in this agreement regarding the scale of clothing, rations, period of engagement, concessions, such as leave and free travelling, and also the rates of pay drawn while in India or on leave, which should be less than the rates on service. With regard to the period of engagement, such indefinite terms as " Duration of the War " should be omitted, and the term of engagement should be for a definite period on service, irrespective of the time spent in depots in India. The hours of work, overtime pay, etc., should be governed by rates of the Directorate in which the men are employed.

It is equally important to have an efficient organization for the purchase and dispatch of stores. The consignee should be informed

as early as possible of articles dispatched, date of dispatch, name of ship or number of the railway wagon containing the articles. In the Mesopotamia campaign, up to the end of 1916, an officer, designated the Engineer Stores Officer, was responsible for the purchase and dispatch of all Engineering Stores, but unfortunately it was not realized what work this duty entailed if it was to be carried out efficiently, and, in addition to his duties as Engineer Stores Officer, he was also A.C.R.E. Bombay, and officiating C.R.E. of the Poona Division. It was impossible for any one man to carry out all these duties, and consequently, until the Munitions Board was organized, this branch of administration left much to be desired.

In those days, it was a pleasure to receive stores from England, as full information was given in the form of packing notes or bills of lading, giving the contents of each package, the marking thereon, so that it would be easily recognized, the particular hold in the ship in which it was carried, and a reference to the original order under which it was consigned. Such information is invaluable, especially in the case of machinery, when the whole plant can be checked without laboriously opening every case and sorting out the parts.

I may cite an instance of how things ought not to be done. The need for ice-making plants in Mesopotamia was early recognized, but because the S. and T. are responsible for the distribution of ice, that Department was deputed in India to purchase the necessary plant. The Director of Works was not informed of what was being done, and the first information received was a notification from a Medical Officer that six ice plants were arriving, consigned to him (the M.O.) by name. A Works Officer was detailed to collect these plants, and eventually about 100 packages, said to contain parts of these ice plants, were found on five different vessels. This was in 1916, and the result was that by the end of 1918 it had been possible to erect two out of the six ice plants dispatched. The balance were incomplete, and being second-hand, and purchased by an inexperienced officer, were not worth the time and labour necessary to erect them.

The purchase of second-hand plant is unfortunately necessary for a big campaign, but the greatest care should be exercised in dismantling and packing, to ensure that everything is complete, and lists made of what each package contains. When purchasing new machinery, this is done by the firm selling the articles, but it is often overlooked when taking over second-hand plant. An experienced mechanical engineer should be detailed for this duty.

If any complaint is received with regard to the suitability of either stores or personnel, fullest consideration should be given to the matter, as the man on the spot knows his requirements, and is responsible.

The marking of packages so that they may be easily recognized is also important, and in addition to the numbers and letters usually

found on all packages, a distinctive coloured band should be painted on every article (except food and forage, etc., which cannot be mistaken), to indicate for which department it is intended. For instance, a red and blue band for Works, yellow for Ordnance, green for another Department, etc. This proved to be a great convenience in Mesopotamia, and resulted in a great saving of time in sorting out a mixed cargo.

If this procedure had been adopted in the return of stores from Duzdap to Quetta, I personally should have been saved a lot of worry in trying to trace stores which had been returned to Ordnance instead of to the Engineer Field Park, and a sounder organization at Duzdap would probably have saved the loss of some lacs worth of stores of all kinds.

I have dwelt rather fully on the organization behind the Lines of Communication, but I consider it a most important point to free the Director of Works and others from the worry entailed in receiving stores and personnel sent in a haphazard manner.

The relation between the Staff and the Director of Works is laid down in *Field Service Regulations*, Chap. III, Section 22, paras. 2 and 3. This requires daily personal intercourse between the Director's Office and the Staff, therefore the two offices should be situated close to one another if possible. Whether the Director should have his Headquarters with the I.G.C. or at G.H.Q. depends on circumstances. In Mesopotamia, the Director of Works remained at Basra until G.H.Q. was established at Bagdad, when his headquarters moved there, and he was then represented at Basra by a Deputy Director of Works, Lines of Communication.

The area between Basra and Bagdad for the Roads and Buildings Section was divided into districts, each under an A.D.W., who had at his disposal sufficient works officers and a works company, or a portion of one, to carry out his duties. Sufficient unskilled labour was placed at his disposal by the Labour Directorate under orders from the Administration Commandant. The charges of these A.D.W.s varied from time to time to meet requirements, but, to give an idea of the organization, I will take a period when there were 2 A.D.W.s at Basra, one at Kurna, one at Amara, one at Kut, and two at Bagdad. At that time, there were more than 200 officers employed in the Works Directorate, and it was found that the Director's office could not exercise direct control over such a large number of A.D.W.s, in addition to the E. and M. Section and the E.F.P.s ; so two Deputy Directors of Works, Roads and Building Section, were appointed, one at the Base and one at Bagdad, from whom the A.D.W.s received instructions.

The head of the E. and M. Section was a Deputy Director, and under him were two Assistant Directors, one at Basra and one at Bagdad, the dividing line of their charges being between Kut and

Amara. At every station, E. and M. officers were in charge of plant, who for technical purposes were under the A.D.W. E. and M. concerned, but in other matters were administratively under the A.D.W. Roads and Buildings or Senior Works Officer at the station, who dealt direct with the Administration Commandant, as representative of the Director of Works.

The Engineer Stores were under the A.D.W. Park, with his headquarters at Basra, and an Advanced Park at Bagdad to supply the needs of the field army, as well as local demands. At one time, there were intermediate Parks at Kurna, Amara and Kut, but eventually these were dispensed with, and the stores transferred or taken over by the Works Officers as a Works Dump.

There should be one large Park at the Base to hold the reserve stock, and Advanced Parks at railheads or other convenient points to supply the field forces, and also Parks at points on the Lines of Communication wherever these lines bifurcate. Intermediate Parks should be reduced to a minimum, as they absorb more personnel than their use warrants.

The organization of the Works Directorate as outlined above grew up in Mesopotamia as a result of trial and error, but with modifications should meet requirements in any campaign beyond the frontiers. All three sections of the Works Directorate have separate functions, but their duties require to be co-ordinated by one head. In splitting the sections into various sub-divisions, it was found that, when the number of sub-divisions exceeded five, it was necessary to re-arrange the charges, and place one responsible head over three or four sub-divisions. The channel of control can be compared to an irrigation system spreading over a large area of country. The headworks are the Director's office, from which the whole system is controlled, and the amount of water passed through represents the work. No one branch should feed more than five subsidiary channels, otherwise the distribution becomes difficult, and that branch fails. The analogy is not quite correct, as by mechanical means the capacity of any branch may be increased almost indefinitely, but the brain of the human being is not a machine, and the limit of its capacity is fixed, except in a few cases of supermen.

I fear I have in some instances departed from my subject, but all I have said is applicable to the organization and working of the Works Directorate on the Lines of Communication, and all has been gleaned from my experiences with the Works Directorate in Mesopotamia.

THE ZHOB VALLEY RAILWAY SURVEY.

By BRIG.-GEN. H. H. AUSTIN, C.B., C.M.G., D.S.O.

IN a previous article* attention was drawn to a proposed extension of the railway beyond Peshawur, *via* the Kabul River, in order to facilitate the maintenance of a force operating in Afghanistan along the line of the historical highway leading through the Khyber Pass. The scene now shifts to Baluchistan.

With the object of bringing Peshawur into more direct communication with Quetta, on the south-west flank of the exposed frontier, General Sir James Browne desired a detailed examination to be made of the country lying between Dera Ismail Khan on the Indus—some 200 miles down-stream of Attock—and Quetta. The distance apart of these two frontier stations by the route sought through the Zhob Valley was roughly 350 miles; and a great saving in distance and time would be effected if Quetta could be thus linked up with a line (since constructed) running along the East, or left, bank of the Indus from Attock to Mari, and south towards Sukkur.

The Zhob district is situated in the north-east corner of Baluchistan, and has an area of close on 10,000 square miles. The country is for the greater part mountainous, but the southern side is traversed by the Zhob Valley, and the northern by the valley of the Kundar, which later joins the Gomal. The chief inhabitants of this area are the Kakars, who possessed little military organization at that period, and were badly armed, for the trade in rifles smuggled into Afghanistan from the Persian Gulf had not touched the Zhob. The Kakars had no love for the British, though they tolerated them, since they were powerless to do otherwise. Still, had they an opportunity to give trouble in times of difficulty, they would probably have made good use of it.

In the upper 80 or 90 miles of its course, the Zhob Valley runs generally in an easterly direction, and then swings N.N.E. for about 130 miles before it is joined by the Gomal from the west. Here the territory of the turbulent Waziris is entered.

Now, it was only in December, 1889, that Sir Robert Sandeman, the Agent to the Governor-General in Baluchistan, first proceeded with an escort of cavalry, infantry and guns on a tour through the Zhob Valley. His object was to explore the country of the Mando Khel tribe down to the junction of the Zhob and Gomal Rivers, and to arrange terms with the Waziris for the opening of the Gomal Pass. Sir Robert started from Loralai—a small frontier station,

* (Kabul River Railway Survey.—*R.E.J.*, Sept. 1927.)

100 miles east of Quetta as the crow flies—on December 19th, and reached Apozai, 100 miles down the Zhob in a N.N.E. direction, on the 26th. Here he remained for some three weeks holding durbars attended by all the leading Zhob *maliks*, and negotiating with *jirgas* of Mahsuds, Zalli Khel, Dautanis and Shiranis. Negotiations completed, Sir Robert continued down the Zhob, leaving a Political Officer at Apozai with an escort of all arms. The junction of the Zhob and Gomal at Kajuri Kach, some 70 miles farther on, was reached by him on January 25th, 1890, and here he crossed the Gwaleri Kotal by the old Powindah caravan route, avoiding the formidable gorge of the Gomal below the junction of the two rivers, and so to Tank on the trans-Indus plain.

"Annexation Bob"—the name by which Sir Robert was sometimes disrespectfully known, owing to his pronounced predilection for acquiring territory for the Crown—thus brought another huge slice of country under British jurisdiction.

It will be realized, therefore, that this fresh railway scheme of Sir James Browne was far more ambitious than the Kabul River one. A great extent of country, little of which was known, had to be closely examined from a railway point of view; and hundreds of miles of alternative alignments would have to be surveyed in order to determine the least expensive route to be followed. Hence the command of the survey operations was entrusted to Major (now Colonel Sir) Buchanan Scott, R.E., an officer of wide railway experience, who had been one of Sir James Browne's Executive Engineers during the construction of the Harnai Railway.

As all field work was to be completed during the cold weather season of 1890–91, Major Scott organized the expedition into five survey divisions, each of which consisted of three R.E.s and two infantry officers, with a subordinate staff similar to that employed by Macdonald on the Kabul River Survey. That survey party complete formed one of the divisions of the new Zhob Valley Survey, and took the field at the Quetta end of the line in September, 1890, with two others. The two remaining divisions commenced work from the Dera Ismail Khan end somewhat later, as the heat in the plains, there less than 600 feet above sea level, was still great.

The Zhob Field Force of 1890, under the command of Major-General Sir George White, then G.O.C. Quetta, and accompanied by Sir Robert Sandeman, was assembling at Khanozai, some 16 miles from Khanai station on the Harnai Railway, at the same time as the survey parties. The military force was destined for the punishment of those sections of the Shirani tribe which had refused to meet Sir Robert at Apozai the previous January, and had for long behaved in a truculent manner. It marched off for the Zhob Valley on October 1st; and the survey divisions commenced work at once from Khanai on the projected railway.

It is scarcely possible, within reasonable limits, to follow in detail the numerous routes surveyed by five separate, though co-operating, parties during the seven or eight months they were working in the field. Macdonald's division had the good fortune, however, to traverse a very large tract of country between Khanai and the junction of the Zhob and Gomal Rivers; and it was given an opportunity also of seeing something of the stupendous gorge through which the Gomal pierces its way, when joined by the Zhob, to reach the plains of India. Consequently we travelled along the entire length of the proposed railway, save that portion lying on the trans-Indus plains. We saw little then, it is true, of the country between Kajuri Kach and Dera Ismail Khan; but a few years later, during the Waziristan Expedition of 1894-95, I was able to bridge the hiatus when proceeding from Wana to Tank and Dera Ismail Khan by way of Kajuri Kach and the Gomal, over the Gwaleri Kotal.

Khanai, the starting point of the projected Zhob Valley Railway, is three stations down the Harnai Railway from Quetta, and is situated about 5,450 feet above sea-level. The suggested alignment immediately commenced a steady ascent to Khanozai, and up the Sarkhab valley to the summit of the Mehtarzai Kotal, the water-parting between the Sarkhab and Zhob. A rise of over 1,800 feet occurs in this first 35 miles or so of the line, necessitating a serpentine course in the latter half to gain distance for a ruling gradient of 1 in 100, when surmounting the steeper slopes of the valley.

Although it was still only the end of October when we reached the Mehtarzai Kotal (7,260 feet), the cold at nights in our camp near its summit was severe. Basins of water in our tents were found frozen solid every morning; whilst the wind was of a particularly piercing nature. Much relief was experienced, therefore, when the progress of the survey enabled our camps to be moved lower down into the Zhob. The fall from the Mehtarzai was something like 1 in 30 at first, which entailed much zig-zagging during the descent of 1,250 feet to Hindu Bagh, distant about 16 miles from the top of the pass. The country hitherto traversed had been truly typical of Baluchistan: bleak and barren to a degree, with scarce a live shrub or blade of grass at the end of summer to break the monotony of stony uplands devoid of trees, save around the few scattered villages near the foot of the hills. The bare frowning aspect of the rugged heights by which we were beset, though not lacking in grandeur, served but to accentuate the inhospitable character of our surroundings. Striking was the change, therefore, to find at Hindu Bagh a pleasant post established amidst an oasis of trees, and garrisoned by a small force of cavalry and infantry; whilst much arable ground in the vicinity had been brought under cultivation by an abundant supply of water obtained from *karez* channels.

As winter was fast approaching, the three divisions which had been

surveying various tracts of country in the neighbourhood of Quetta, now received orders to cease work in that area for the present and to march down to Apozai. Thence, the course of the Zhob and Gomal Rivers, and other alternative routes, were to be surveyed during the most severe months; and a return would be made to complete the upper portions of the railway alignment in the spring.

Thus it was with light hearts we set forth for more genial climes, as the high hills around were already capped with snow when we marched from Hindu Bagh on November 22nd. The district road constructed from Khanai ceased at Hindu Bagh, and onwards there existed but a rough path leading down the Zhob for 130 miles to Apozai. In this distance the Zhob falls about 1,500 feet only—from 6,000 to 4,500 feet above sea-level—and as the valley is generally open, and several miles in width, it presents few difficulties from a railway point of view.

Despite some unpleasantly long marches for our slow-moving camel transport, and heavy rain throughout several days, we managed to obtain a good deal of small game shooting during this trek. The perpetual stones of the Quetta plateau gave place in parts to soil of a grey clayey nature, extensively cultivated about villages, the land being irrigated by means of ingeniously derived water-channels.

Shafts are sunk as much as 80 feet deep on sloping ground to reach water. Should water be struck, a succession of shafts, every thirty or forty yards apart, is sunk lower down the slope; and these are connected together at their bottoms by low tunnels. Since the fall of the ground is far steeper than that necessary to ensure a flow of water from one shaft to another, it follows that the depth of each succeeding shaft can be greatly reduced, and the water thus gradually brought close to the surface, when it is run along open channels to irrigate fields over a considerable area of ground.

These *karez* shafts furnished abodes for many blue-rock pigeon, and very pretty shooting could be had by throwing a few clods down them. Their alarmed occupants would then come bustling up with a great beating of wings in the confined space, and as they dashed off on their flight when reaching the open they afforded quick snap-shooting to guns distributed around the shaft. Large flocks of blue-rock were seen, too, circling about the cultivated areas; whilst numerous sand-grouse, chikor, sisi, duck, teal, plover, and hares, kept our stock-pot going throughout the journey down the Zhob.

Few incidents of note disturbed the even tenor of our way. White men were rarely met, though we did camp one night alongside an Irrigation Officer, examining the possibilities of the country under the protection of a small escort. Whilst dining with us, he scoffed at all idea of being molested by the local natives, but soon after our arrival at Apozai he came tumbling in there precipitately. A gang of *budmashes* on the rampage had suddenly appeared in the vicinity

of Gwal Haidarzai, where we had forgathered, and he considered that was not a healthy spot in which to linger with his few sepoys.

The most conspicuous landmark in that part of the Zhob is a huge pyramidal rock, Smakhwal by name, which rises abruptly to a height of 450 feet from the plain-like valley, some 20 miles short of Apozai. Viewed from our previous camping-ground it seemed but a few miles distant. Yet after a weary tramp of 20 miles we had only come abreast of it, and our stage was still 3½ miles beyond at Badanzai. Our camels were nearly twelve hours on the road, and it was dark long before camp was pitched; so, being on rear-guard duty that day, I have good cause to remember the elusive form of Smakhwal as we crawled towards it the live long day.

A further march of 16 miles, however, landed us at Apozai, now known as Fort Sandeman, on December 2nd, and here we found ourselves again in a small frontier station recently established. Only six months before had a start been made on the sun-dried brick huts and buildings which accommodated, at the time of our arrival, an Indian Pioneer battalion, two squadrons of Indian cavalry, and two guns of an Indian Mountain Battery. The Political Officer's palatial stone residence was built on one of several small eminences within the limits of the little cantonment, and was occupied by Lieutenant (now Colonel Sir Henry) MacMahon, then a most energetic young frontier officer and destined to be a future Agent to the Governor-General in Baluchistan.

Apozai, though a veritable outpost of Empire in those days, was in telegraphic communication with Loralai, and with one or two lesser posts farther down the Zhob, such as Mir Ali Khel. The country round was still in a very unsettled state, however, and officers were not permitted to go out riding except in pairs, and armed with revolvers. Thefts of camels, and other transport animals, by tribesmen were frequent, and fanatical outbreaks common. A few days before our advent, a gang of coolies, employed on road-making ten miles down the Zhob, were cut up by a band of *ghazis*; while several of our camels were stolen, together with those belonging to other divisions, during our short halt at Apozai.

The morning our division marched for Gul Kach, on the Gomal River, a great uproar occurred in the cavalry lines as we were passing it. A Mando Khel, seemingly strolling unconcernedly by, suddenly turned *ghaza*, and drawing his sword rushed at a sowar of the 12th Cavalry, whose head he nearly severed with a blow on the back of his neck. Before anyone could check him, the *ghazi* slashed another sowar across the arm, and a third over the hand. The other sowars, then realizing what was afoot, made a dash at the fanatic with drawn swords and quickly cut him to pieces. His mangled remains were then burnt as a deterrent to such other natives as might desire to emulate his example; and Paradise thus denied him.

In anticipation of trouble in the lower reaches of the Zhob and

Gomal, our Pathan *khalassies* had all been armed, some with rifles and others with swords, whilst engaged on the survey about the Mehtarzai Kotal. We had drilled and trained them in the use of their weapons; and our camps were pitched in perimeter fashion with tent ropes overlapping, their defence by night being tested by occasional surprise alarms. We had started from Khanai with an escort of twelve Bombay sepoys under a havildar, but they proved so incompetent and insubordinate that we returned them to their battalion at Peshin early in November, and continued without them. Now that we had reached more disturbed regions, however, escorts of a more efficient nature were provided for the survey parties.

A few days were spent in preliminary surveys about Apozai, in the hilly tract some 13 miles to the west of the station, and beyond the Zhob River which was still fordable. We then returned to accompany the 3rd Baluchis and a squadron of the 12th Cavalry to Gul Kach. This column was joined by MacMahon as Political Officer, and was commanded by a noted frontier soldier, Colonel Nicholson, the husband of "Laurence Hope." A personal escort of 50 men of the Baluchis, under an Indian officer, was furnished for our survey division; but the whole force marched together through some 50 miles of very difficult and broken country, the abode of many bad characters, that intervenes between Apozai and the Gomal River.

Here, at Gul Kach, our environment was wild in the extreme. The summits of the higher hills around were already white with snow; and our camp on the right bank of the river, towards the eastern limit of the Domandi plain, overlooked its broad stony bed down which five or six fordable channels were flowing. The opposite bank, and the country beyond to the north, was then temporarily recognized as the territory of the Amir of Afghanistan; but was later allotted to India in accordance with the terms of the Durand Treaty. Near by, to our right, lay the entrance to the gorge of the Gomal, which extends almost without a break for 25 miles before joining the Zhob at Kajuri Kach.

A short distance above the gorge, and on the left bank, one's gaze was arrested by a confused mass of clay cliffs and mounds beneath which, if local legend is to be believed, are buried the ruins of Sodom. The Almighty had, it is said, become so wrath at the evil doings of its inhabitants that He had plucked the city up by the roots and hurled it back into position upside down. Hence this turmoil of sand and clay, reputed to be haunted by *jin*, or spirits, to this day. A horseman and two women are said to be seen at certain seasons wandering disconsolately among the ruins, but they did not cross our path; while, at a later date, the so-called ruins of Sodom were pointed out to me on the banks of the Tigris, not far down-stream of Kut. Some rivalry seems to exist, therefore, between Pathan and Arab for the possession of the site of this notorious town.

The Baluchis and cavalry went into permanent camp at Gul Kach as a covering force for the various survey divisions working in the neighbourhood. One division under Captain (now Colonel Sir John) Pringle, R.E., was to survey down the Zhob from Apozai to Kajuri Kach; another, under Captain (now Brig.-General) G. S. McD. Elliot, R.E., between Apozai and Gul Kach; and ours between Gul Kach and Kajuri Kach. The other two divisions, under Captain (now Major-General) C. H. Cowie, R.E., and Captain (now Major-General Sir John) Capper, R.E., were at work between Dera Ismail Khan and the exit of the Gomal into the plains of India, and in the Gomal gorge itself below its junction with the Zhob.

At Gul Kach we were about 3,000 feet above sea-level, a fall of some 1,500 feet between Apozai and that place; but in the first 17 miles out of Apozai, by the route our division had marched, the ground rises nearly 500 feet to the Nawa Oba Kotal. A descent of close on 2,000 feet over very intricate country in the last 35 or 40 miles to Gul Kach would, therefore, be entailed in obtaining a railway alignment to that point. Subsequent observations showed that the fall of the Gomal between Gul Kach and Kajuri Kach is less than 900 feet in a distance of 26 miles; so the question of gradient is comparatively simple. But the character of the country between the two places would make the construction of a railway almost prohibitive in cost.

Indeed, we estimated in the field that the cost of this 26 miles of railway would amount to a sum not very far short of that for the entire Kabul River Railway of 55 miles between Peshawur and Dakka. The Gomal would probably require to be crossed three times by large bridges between Gul Kach and Kajuri Kach; and no less than twenty-four tunnels, with a total length of about $3\frac{3}{4}$ miles, would also be necessary in this section.

In any event, between Apozai and Kajuri Kach, the more direct route adhering to the 70-mile course of the Zhob was shown to be a much less costly proposition. But even here, owing to the confined nature of the sinuous valley, enclosed to a great extent by lofty hills and broken slopes, the construction of a railway would involve very heavy work, though a steady easy gradient is procurable.

We were the first Europeans to penetrate the gorge of the Gomal between Gul Kach and Kajuri Kach; so I propose entering into somewhat more detail of our experiences whilst surveying in it. The route between Apozai and Kajuri Kach by the Zhob was already pretty well known, for a frontier road was in course of construction down it, and posts had been established at certain stages along it.

Soon after our arrival at Gul Kach, Macdonald deputed me to lay out a road down the gorge if possible, with a view to enabling us to work towards Kajuri Kach along it. I was thus the first white man to enter it; but, after following the gorge for a couple of miles, it became clear that a large amount of labour, and much

time, would be involved in making a camel track through, owing to the slender means at our disposal and the precipitous nature of the narrow rocky defile the river had carved out as its course. The idea had to be abandoned, therefore, and it was decided that the division should march to Kajuri Kach, and work up-stream to Gul Kach instead.

Since the gorge route was impracticable for heavily-laden camels, MacMahon supplied us with a dozen Sulaiman Khels, who were to conduct us into Amir's territory across the river, over the Kandori Kotal and thence into the Gomal again, close to where the Toi River, flowing from the Wana plain, joined it on the left bank. Fording the Gomal at Gul Kach, our nervous guides led us some three miles north along the foot of sand cliffs, and then turned east up a large nullah rising near the Kandori Pass, a spot of evil repute as the haunt of marauding Waziris. The ascent of 700 feet from the Gomal was comparatively easy, though the pass is shut in by high cliffs; and whilst seated on the summit, enjoying a light lunch, we discerned the forms of men standing out against the sky-line, 1,500 to 2,000 feet above, but they made no attempt to molest us. The descent on the far side, on the other hand, was very difficult for our camels, the track being rocky, rough and broken for the first two miles. We then entered a narrow valley down which eight or ten parallel tracks ran side by side, for we were now on the Powindah highway by which Ghilzais and other traders travel between Ghazni in Afghanistan and India.

This valley gradually decreased in width until it became little more than the low cliffs of a large nullah, down the bed of which the tracks continued to another nullah that took us to the Gomal, a short distance above its junction with the Toi. The Gomal was again forded and camp pitched on a small stony plot of high ground, known as Toi Khula, which overlooked the stream.

By this detour of some 15 miles in the Amir's territory we had circumvented twelve to thirteen miles of the sinuous Gomal gorge impracticable for camels, and were now half-way to Kajuri Kach. Next day, however, was Christmas Day, so we remained halted and spent a thoroughly miserable Christmas. At dawn the rain was pattering, not unpleasantly, on our tents—quite reminiscent of home. But when a furious gale sprang up in addition, seasonable sensations evaporated, for our tents were with difficulty restrained by their pegs and ropes from embarking on aerial flights, and we anxious occupants were chiefly engaged in clutching on to camp tables, chairs and other articles, lest these should be transported bodily into the river below. As the hurricane of wind blew direct from the snow-clad hills without, it was truly arctic in its bitterness, and intensified our discomfort.

Our well-planned Christmas dinner, too, proved something of a frost, since the turkey, plum pudding and champagne we had ordered

from Lahore, to do honour to the festive occasion, had become stranded at Dera Ismail Khan, and thus failed to reach us in time. When the turkey did eventually arrive in its air-tight tin, weeks later, it was accorded a decent burial, as we quickly discovered there was no other use to which it could then be profitably put.

The gale continued throughout the night, and only died away in the early morning. It was horribly cold and freezing hard when we set out on the march of twelve miles to Kajuri Kach; and the river had to be forded a number of times—a cheerless procedure as the water was waist deep, and rapids frequent. This portion of the gorge was practicable, however, for transport animals by crossing at intervals from one bank to the other, in order to take advantage of such narrow strips of gently sloping ground as existed between the foot of the cliffs and the river.

Camp was pitched on the right bank of the Gomal at its junction with the Zhob, which entered from the S.S.W. The beds of both streams here opened out to an astonishing extent, that of the Zhob being 500 to 600 yards wide, and the Gomal close on 400. As in times of flood both rivers completely cover their beds, a magnificent spectacle is then presented by their boisterous meeting. A defensible post occupied by Zhob Levies was situated on the right bank of the Zhob, on high ground overlooking the junction. It was supposed to afford security and protection to all and sundry travelling by, or camped under the shadow of its walls; but the experience of the Sulaiman Khels, related in *Waziri Ways*, shows that it scarcely fulfilled its function.

We were now in touch with one of the survey divisions at work on the Dera Ismail Khan end of the line, under the command of Captain Capper. He was camped some 5½ miles down the Gomal below its junction with the Zhob, and was faced by the most difficult problem of the whole Zhob Valley line, that through "Browne's Gorge." Capper cordially invited us to visit him, that we might see something of this really remarkable freak of Nature; and pleased we were to take the opportunity of doing so.

Crossing the broad bed of the Zhob just below the Levy Post, we proceeded down-stream to find ourselves soon confronted by a narrow opening between magnificent precipices towering hundreds of feet above us. Here we had to leave the river bed, and followed a branch nullah on the left bank which led to a rough pathway, cut by Capper, in the slopes of the hills. Continuing over broken ground, amid numerous fantastic pinnacles and ridges, we descended by a zig-zag track to the bed of the Gomal again; and at once passed through a gap between two gigantic boulders, one of which was 60 feet in height, and as many yards in circumference. It went by the name of "Adam's Kark," for that early man is credited, in local lore, with having pasted his dough round this modest stone before baking it in a fire for his bread. Near by was another large

curious-shaped rock, with a great hollow scooped out of it, which was known as "Adam's Chilamchi," or basin, because he washed his hands in it prior to partaking of food. A turn to the left, a short way on, brought us to Capper's camp, perched on a small plot of ground on the left bank of the river, 15 to 20 feet above the water level, and closed in on all sides by stupendous precipices.

Later, we rode farther down the river bed, crossing and recrossing the stream which was then 30 to 40 yards wide, three feet deep at the fords, and flowing swiftly in a series of short rapids. A mile below Capper's camp the river made an extraordinary bend of nearly a complete circle of small radius before entering the famous "Browne's Gorge"—thus named after General Sir James Browne, the first European to view it. We had to dismount at the mouth of the gorge, and proceeded on foot by a rough path then being constructed by Capper's Waziri coolies along the face of the cliffs.

The scenery here well-nigh baffles description. Immense precipices of hard limestone rock rise aloft nearly 1,000 feet, and almost sheer on both sides of the chasm. Nowhere does this exceed a width of 30 to 40 feet at its base, and the cañon twists and turns bewilderingly, while the combined waters of Zhob and Gomal surge furiously down the narrow winding cleft for a distance of three-quarters of a mile. The cliffs then begin to open out again gradually to 30 or 40 yards; but in times of flood so tremendous is the struggle by the impounded waters to force their passage through this puny aperture that they become banked up to a height of 60 feet above the normal cold-weather level. It will readily be understood, therefore, that much tunnelling would have to be resorted to, in order to overcome Nature in this awe-inspiring rift in the mountains.

The Gomal remains confined to a winding gorge of noble proportions for some 25 miles below Kajuri Kach before it enters the plains at Murtaza, distant about 18 miles from Tank. In the 50 or 60 miles between Murtaza and Dera Ismail Khan, the railway would traverse open, though broken, plains presenting no special engineering difficulties. A considerable amount of cultivation exists thereabouts, for the irrigation of which the waters of the Gomal are practically all absorbed and little usually reaches the Indus.

After this instructive and most interesting glimpse of Capper's problems, Macdonald's division commenced working up the Gomal towards Gul Kach from Kajuri Kach; and a few Dautanis were attached to our survey party in place of the Sulaiman Khels, who returned to their homes in fear and trembling lest they should encounter Waziris *en route*. The Dautanis were supposed to be at peace with Sulaimans and Waziris alike; and their presence in our camp was intended to serve as some safeguard against outside interference by the Waziris, on whose border we now were. Nevertheless, as our work progressed slowly up the gorge, and camp moved at intervals farther and farther up the Gomal, thefts and alarms

became almost a nightly occurrence at one time. Though one could not entirely withhold admiration for the cool audacity of these Waziri thieves, their activities sorely interfered with our nights' rests after hard days of toil in the field.

As I have already attempted, however, to give readers of the *R.E. Journal* some idea of our experiences then in " Waziri Ways," I need not stress the subject further here. It will be sufficient to state, therefore, that the survey from Kajuri Kach to Gul Kach was much hampered also by the vile weather, which frequently prevented out-door work being done. What with rain, furious gales, snow, hard frosts, a swollen river, and difficulties of terrain to contend with, it was February 16th before our work joined up at Gul Kach with that of Elliott's division, which had been surveying to that spot from Apozai. A few days later, we marched by a new route across the Girdao plain to Mir Ali Khel, about mid-way between Apozai and Kajuri Kach along the Zhob.

Here a strong post had been built, and was garrisoned by 150 men of the 2nd Sikhs and half a squadron of the 3rd Punjab Cavalry from Dera Ismail Khan. Notwithstanding their presence, this locality possessed an unsavoury reputation for lawlessness Outrages were of frequent occurrence up and down the frontier road under construction, and night alarms were an almost everyday affair. Consequently, Lieutenant Vesey, the officer then in command of the post, led a stirring life, and had many a grisly, sometimes humorous, story to unfold during the several occasions we were encamped outside the stalwart walls of his fort. Even there we did not escape nocturnal molestation from gangs of blackguards who infested the wild neighbourhood.

The next month was employed on branch surveys between Mir Ali Khel and Gul Kach; and we spent the best part of a week, too, about the Kandori Pass, whither we returned in order to examine an alternative line, avoiding the upper half of the Gomal gorge near Gul Kach.

Shortly before, when working in the Siri Toi near Mir Ali Khel, one of our *khalassies* foolishly strayed from the line of march, and was, presumably, murdered immediately by some *budmashes*. In any case his body presented a horrible spectacle when ultimately recovered by a search party, sent out after dark with lanterns on his absence from camp being reported. Nothing was ever seen, of course, of his assailants, though the broken country was scoured far and wide for them next morning.

We were back at Mir Ali Khel for the last time on March 20th; and the following day commenced the return journey to Apozai by the Zhob Valley route, bound for resumption of survey work on the upper sections of the line between Apozai and Hindu Bagh. A fine frontier road along the right bank of the valley made the march of 36 miles, in three stages, a very simple affair. But the road by no means adhered entirely to the course of the river, which, confined

between close-set heights, indulges in some perplexing contortions in this area. Nevertheless, it was abundantly clear to us that the Zhob between Apozai and Kajuri Kach presents far less difficulties than the Gomal alternative between the same two places.

Divers traders, and other natives, attached themselves to our column with their laden camels and mules during our march from Mir Ali Khel, as the lawlessness then rife in this district caused them to seek protection under our wing. Even so, we met one poor way-farer who had just been set upon by Waziri *budmashes* in a turn of the road on ahead. He had been robbed of all he possessed and badly slashed as well in three places by their keen swords. Macdonald and Gloster, with the advanced guard, started off with a few sepoys in pursuit of the ruffians, but saw no trace of them. One seldom did; yet they were always lurking amid the hills on the look-out for whom they might devour.

Pringle's division, which had earlier surveyed the Peshin section of the upper alternatives, and had recently completed that from Apozai down to Kajuri Kach by the Zhob route, now began to work up from Apozai towards Hindu Bagh; while Macdonald's division marched up the Zhob to the vicinity of Hindu Bagh, and worked down the valley to meet Pringle. This survey progressed at so rapid a rate that by April 19th the gap of 130 miles had been bridged by the two divisions, and the railway alignment clearly marked out on the ground between those two places.

The next fortnight was employed, however, in making further improvements in the original alignment on both sides of the Mehtarzai Kotal. Thus it was May 5th before our work in the field was finished, and we were free to return to Quetta.

During our five months' absence from this area of the Zhob, the appearance of the country had undergone a remarkable change. In the autumn all was bleak, dried-up and drab, but in the meantime the seemingly sterile stony soil had been quickened by winter sleet and snow. Now, in the spring, one's eyes were refreshed with a sense of colour. The former all-pervading, sun-scorched camel thorn, had burst forth into green young leaves, creating an air of life and cheerfulness. And, strangest of all, out of the unpromising earth bulbs and flowers had forced their way, and were in full bloom. The ground was gay with red and yellow tulips, poppies, hyacinth-like blossoms, purple bells, diminutive pansies, and other species of wild flowers which almost brought beauty into our surroundings.

Nor were we the only ones to appreciate the altered conditions of Nature, for myriads of locusts now assembled—as in the Kabul River at the same season the previous year—to take toll of the green refreshment supplied. On several occasions whilst at work, the sun was completely obscured for an hour or more by dense clouds of countless locusts overhead. The ground, too, was thick with them, and they were gathered up in sacksful by the Kakars, who dry their

bodies and grind them into flour. Traffic up the Harnai Railway was even impeded by hosts of these insects, for their crushed bodies so lubricated the rails that locomotives and carriages had some difficulty in surmounting the stiff gradients in places.

The three remaining divisions had meanwhile been carrying out various important alternative surveys in the uplands; and at the close of the season's work, Major Scott could congratulate himself on the fact that a most thorough examination of every possible route between Quetta and Dera Ismail Khan had been made. The personal energy of Major Scott throughout the work in the field had been inspiring to all. He was ever on the move from one division to another, spending a few days in this camp, and then in that; so that he might see for himself the difficulties of terrain, and advise how best to overcome them.

He was frequently accompanied by Mrs. Scott, who defied every form of hardship and danger, so enthusiastic was she to learn all about the country, and the multifarious problems that confronted her husband in the great task committed to his charge.

The Scotts and the R.E. officers of all five divisions later assembled at Dalhousie, where, in the summer months of 1891, comprehensive reports, plans and estimates were prepared on the information gained during their combined labours in the field.

Since those days the railway from Quetta has been extended in a north-westerly direction to the Afghan frontier at Chaman, by piercing the Khojak Pass with a tunnel $2\frac{3}{4}$ miles in length. In a westerly direction it had reached Nushki before the Great War, and during the War the line was carried still farther over the sandy wastes towards Sistan. But no attempt has yet been made to connect Quetta by a broad-gauge railway with Dera Ismail Khan, *via* the Zhob and Gomal. This, though shown to be perfectly feasible, is presumably due to the decline of the Russian menace; and to the costly nature of the undertaking, as disclosed by the investigations of the Zhob Valley Railway Survey parties thirty-seven years ago.

Nevertheless, a two-foot gauge line was built from Khanai to Hindu Bagh some years ago, in order to convey valuable chrome deposits thence to the main railway system; and this light line is now being extended down the Zhob. It has already (June, 1927) reached Kila Saifulla, some 40 miles beyond Hindu Bagh, and I understand is likely to be carried on the remaining 90 miles to Fort Sandeman. The large increase of the garrison at that cantonment in recent years has added much to the difficulties of maintaining this force in so advanced a position without the aid of a light railway.

It may well happen, therefore, that, in the years to come, some young R.E. officers of to-day will be called upon to construct, in its entirety, the Zhob Valley Railway line surveyed by Major Buchanan Scott and his colleagues in 1890–91.

THE PRESENT POSITION AS REGARDS MECHANIZATION.

By BT. LIEUT.-COLONEL G. LE Q. MARTEL, D.S.O., M.C., R.E., M.I.MECH.E.

IT is so attractive to write and read about the eventual future of mechanization, that the present position is seldom described as clearly as other subjects which lend themselves less to future forecasts. That we need some policy to guide us, as the ultimate aim in mechanization, is obvious, even though we know that our forecasts will be as inaccurate as any other prophecies, but the whole subject is so beset with difficulties at this stage, that the present position and immediate future need constant study and constant change in immediate policy in order to achieve our objects with the least possible delay.

From the moment that mechanical warfare was introduced in 1916, there arose a demand for mechanical assistance of this nature in many directions. In addition to tanks, track vehicles were ordered for supplies and ammunition, for the transport of artillery, for engineer work, and for many other duties, and the whole subject was grouped rather loosely under the term "mechanical warfare." This resulted in a somewhat confused state of thought, and in order to make a logical division between the various ways in which we can obtain assistance from these vehicles, the subject may be divided into three branches—strategical, tactical and administrative mechanization.

Strategical mechanization is used to move troops and reserves from one part of the battlefield to another with great rapidity, *e.g.*, if the necessary vehicles are available a complete division can be moved 100 miles in 24 hours, and if the vehicles are of a cross-country type the move can be carried out across country, where the enemy has endeavoured to impede progress by the use of extensive demolitions. Having arrived at their destination, the troops may or may not be assisted by armoured vehicles, but the object of strategical mechanization is a rapid movement over a long distance.

Tactical mechanization is used to enable troops to fight on the move and behind armour on the battlefield, *e.g.*, the tank, the armoured car, and the gun on a self-propelled mounting.

Administrative mechanization is quite another matter. It is used mainly to assist the administrative services. First of all, there is expense under peace conditions; properly organized mechanical

transport is far cheaper than the equivalent in horse transport. Secondly, there is the question of the transportation of forage or petrol to maintain the transport of an army in the field, and very great savings can be effected in both bulk and weight when mechanical transport is substituted for horse transport. This is particularly important in an overseas war, when the available sea transport is limited. Lastly, there is the question of the difficulty of maintaining the fighting troops when they have advanced across country where extensive demolitions have been carried out, or when they are a long way from railhead. Under these conditions, cross-country mechanical transport can often compete with requirements which could not be met in any way by horse-drawn transport.

In strategical mechanization we are now in a position to make good headway. For a long time we floundered with track and semi-track vehicles, until the R.A.S.C. came to our rescue with the six-wheel lorry. A start has already been made in mechanizing the first-line transport of infantry battalions with these vehicles, and there is every chance of their commercial use, which may ease the mobilization difficulties, and pave the way for a considerable extension in mechanizing first-line transport. This will overcome the main difficulty of strategical mechanization, for, although there has never been any great difficulty in collecting buses and lorries for the rapid movement of dismounted men, the movement of their first-line transport has represented a serious difficulty in the past. With the use of six-wheel lorries the first-line transport can travel with the buses, and the whole unit can cover very long distances at a high speed. There are, of course, some forms of tactical mechanization which bring with them strategical mobility, but the necessity of carrying armour reduces this mobility in a large degree. The Vickers tank, for instance, is far less mobile than a six-wheel lorry under average conditions; the mobility of the armoured car is second to none, but this is achieved by the use of very vulnerable wheels, which reduces to a large extent its tactical value. It is possible that small track vehicles of the Carden Loyd type may combine the advantages of tactical mechanization with strategical mobility, but, generally speaking, these two branches pull against each other, and advantages in one direction, such as the provision of armour, can only be obtained at the expense of the other. The advantage of strategical mechanization is obvious to everyone; it renders no assistance to the infantry-man in a frontal attack on the battlefield, but if a force of one or more infantry divisions can be moved rapidly to the flank or rear of the enemy position, then the battle may be won without the use or necessity of any armoured fighting vehicles at all.

Administrative mechanization is closely wrapped up with the progress that we are making in strategical mechanization. The six-

wheel lorry brings with it a great saving in financial expenditure, and a large reduction in the shipping tonnage required to maintain an overseas force. Even a wide belt of extensive demolitions has less fear for a force that is well provided with these vehicles. The dragon, like all whole-track machines, is a very inefficient form of transport, but its replacement by the six-wheeler enables us to combine the advantages of administrative and strategical mechanization, particularly if we develop a well-designed type of "artillerie portée," in which case a very high speed on roads can be maintained, combined with low running costs.

It is with tactical mechanization, however, that we enter on to controversial and difficult subjects. Here the six-wheeler is of little value. It is true that six-wheel armoured cars will be useful for long-distance reconnaissance, but their fighting value will be very small. Their mobility is entirely dependent on the pneumatic tyre, which is very vulnerable. It is true that these tyres can be replaced by semi-solid tyres of various types, which are unaffected by bullets, but these tyres reduce the cross-country capacity of the vehicle, and the speed on roads, to a considerable extent. Six-wheelers will, therefore, be limited to armoured reconnaissance, and armoured mounts for officers and staff, and although these duties are important, they represent only a small part of the work of armoured fighting vehicles. The present trend of thought is to divide the use of these vehicles into two branches—the employment of armoured fighting vehicles, to assist normal formations, and the employment of an independent armoured force.

The former is far less controversial, as it has two years of war experience on which to base deductions. That infantry will be assisted by tanks in the attack for many years to come is certain. For mobile warfare the light tanks, which were formerly known as tankettes, may prove to be the most suitable, but as warfare becomes stabilized the tanks require an obstacle-crossing capacity, and it is necessary to use longer and heavier, and less mobile machines. Anti-tank weapons have been developed, to repel the tank attacks, but, so long as we are dealing with limited objectives in fairly stabilized warfare, the anti-tank weapons can be neutralized by artillery fire and smoke. Future progress on either side is likely to balance under these conditions, and tanks of every type are likely to play an essential part in the assault for many years to come. Whether these fighting machines will form part of infantry units, or be organized in separate units, is a detail which will be adjusted as time progresses.

The employment of an independent mechanized force, however, lends itself to controversy in many different directions. At one time, in the distant past, cavalry were all-powerful on the battlefield, and

infantry were camp-followers and moppers-up, and the hope is expressed that the independent armoured force may re-introduce this superiority of the mounted arms in a modern form. No one supposes that this superiority would last for ever, but if it is to exist for a certain period, we, as a nation, must be first in the field. Moreover, as we depend primarily on a small regular army, the introduction of an independent mechanized force suits our case. Our men are highly paid, and our small regular army costs as much as the large conscript army of a European country. By roughly halving the numbers of men we can save enough money to mechanize the other half, and we can thus obtain an efficient, highly-trained mechanized force with no increase in financial expenditure. With a European country, such as France, the position is quite different. The efficiency of a conscript armoured force is very doubtful, and in any case when the men are practically unpaid, very big reductions have to be made to pay for the mechanical vehicles. France would, therefore, be reduced to a very much smaller army, if she wished to indulge in any large degree of tactical mechanization, and this would be a dangerous experiment with a country which has a land frontier 300 miles long. In order, therefore, to try out these ideas, and obtain some practical data, an armoured force was formed at Tidworth in July, 1927. Just as we were the first to develop and use tanks in the Great War, so we have been the first to take the next step, and develop an armoured force, and with our present start we should be able to maintain our lead ahead of other nations.

Our present force is a quaint collection of various types of vehicle, but it was far better to make a start with vehicles which were available than to wait for more perfect machines, which might then be developed on wrong tactical lines. At present, many of the vehicles are unarmoured, and that they should all be armoured is agreed to by everyone, but the main controversy rests round the tank. The striking force is at present the Tank Battalion, armed with the Vickers tank, and this is both the least mobile and the most expensive unit in the force. This reacts in two ways; first of all, these tanks hamper the mobility of the force, and secondly, as the vehicles are expensive, they cannot be numerous, and as they have to present a concentrated form of attack, they are liable to heavy casualties from anti-tank weapons. There are many things which are uncertain in the near future, but the one point which does appear to be reasonably certain is that the field artillery and the anti-tank weapons, with which the infantry battalions will soon be equipped, will deal heavy casualties to an armoured force which attacks with a limited number of Vickers tanks. If the force is to lose 50% of its tanks in an attack against an infantry division, then the game is not worth the candle. These anti-tank weapons can be neutralized by smoke and artillery fire, but this pre-supposes a set-piece attack, and for this purpose the

fighting vehicles would be better employed with a modern form of infantry division. To be of any great value, the armoured force must be able to attack a normal formation which is on the move, without any delay, and be capable of carrying through the attack with success and without undue casualties. The first requirement in this direction would appear to be to increase the mobility and reduce the cost of the Vickers tank, so that we can use dispersion and attack with a very large number of tanks. This was foreseen over two years ago, and as a first attempt to solve the problem the Morris-Martel tankette was constructed. This first model had certain faults, and as neither the makers nor the War Department were prepared to develop the machine, little headway was made until the firm of Carden Loyd came to the rescue. These engineers were prepared to devote their whole time to the development of a small cheap tank.

Their first models were unsuccessful, but by July, 1927, they had produced their fourth model, which competed successfully with the first model of the Morris tankette, and their later models showed still further improvement. What form the future light tank will take is uncertain, it may be of the whole-track or half-track type, and it may develop into a larger and more expensive machine than the present light tank. As regards armour, it may not be possible to provide all-round protection against ·303 armour-piercing bullets at normal impact and at close range, but, provided the front of the machine is proof at close range, and the sides and rear at long range, the light tanks should have no difficulty in subduing all opposition from small arm fire, provided they are used in large numbers. It is these large numbers, again, that will provide safety against anti-tank weapons, for the attack of a swarm of these small fighting vehicles, moving at high speed, will have a most demoralizing effect on the defence. It, therefore, appears likely that there will be a period during which the armoured force, based on a large number of small fighting vehicles, backed up by close support artillery equipped with a very light form of armoured self-propelled mounting, will be very powerful, and, perhaps, decisive, on the battlefield. There will, of course, be many difficulties to be faced, such as administrative questions, but these are the lesser problems, and they will certainly be solved.

In conclusion, it would appear that we are quite safe in going ahead with strategical and administrative mechanization; increased mobility and better administration are of unquestionable value. An article by Major B. C. Dening, R.E., which appeared in the December number of *The R.E. Journal*, gave a very practical scheme for the mechanization of first-line transport, which might take us a long way in this direction. Even India, that is always accused of retrogression, is moving fast in strategical and administrative mechanization, based mainly on the six-wheel lorry. It is in tactical mechan-

ization that it is so difficult to see ahead, and in which we are up against very real difficulties. Portions of our army must be able to fight in mountains, where fighting-machines are of little value, and then there is the Cardwell system, which must change before we can make progress in this direction. We shall, however, learn much about the tactical side of mechanization during the next few years—both as regards the independent armoured force and the assistance which fighting vehicles can give within the normal formations. It may then become necessary to reorganize the army gradually. In the meantime there is much to be studied. In many places abroad, fighting vehicles would be of great value, and would enable reduction in numbers to be effected. In other places, the possession of an all-powerful army for use on the plains, which we can obtain by the use of suitable fighting vehicles, will render the mountain warfare of much less importance. It is possible that the success of the independent armoured force may be such that the greater part of the army will be organized in this way, and that mountain warfare will be carried out by special troops, or even men temporarily dismounted from a mechanized force. In some stations abroad the regular troops may be entirely mechanized, and the defence of bases and communications be relegated to volunteers or local troops. In the case of our expeditionary force, the divisions may be almost entirely mechanized, depending on our allies and, at a later stage, on our territorial troops, to hold defensive sectors, and to guard communications and bases. At the same time, it is possible that anti-tank weapons will develop more rapidly than we anticipate, and that armour will have a short life. In this case we should be limited mainly to strategical and administrative mechanization, and with these we should progress at full speed, because their value is certain, but with tactical mechanization we must go carefully, as we are on less sure ground.

THE SHANNON HYDRO-ELECTRIC POWER DEVELOPMENT.

By LIEUT. J. V. JENKINS, R.E.

THE following notes, which are in continuation and amplification of the account of the Shannon scheme published in *The R.E. Journal* for June, 1927, were made after three visits to the works during that year, the last being late in November. A rather fuller description of some of the most interesting plant, which was briefly noticed in the previous article, is included.

I. PROGRESS DURING 1927

(*a*). *Headworks.*

The works on the site of the weir, above O'Briensbridge, have now reached a stage at which it is possible to realize without difficulty the transformation of the surrounding country which will take place when the scheme is completed.

The first section of the cofferdam, next the right bank of the Shannon, has been finished, and the steel framework for the second section, that contiguous to the left bank, is being put in position. The central section, it is hoped, will be erected during the summer of 1928, when the water of the river is at its lowest. The problem of dealing with the flow when the water-way has been completely obstructed, but the full width of the weir is not yet available, will thus be made easier. The current through the restricted channel, where the water rushes past the end of the cofferdam, at an estimated speed of 10 ft./secs., impresses the observer with the desirability of waiting for drier weather before diminishing the passage still further.

Meanwhile, the excavation for the foundations of the weir is proceeding inside the first section of the cofferdam, the walls of which are about 6 ft. thick, and are composed of puddled clay, contained within 9 in. by 3 in. timber sheeting. The timber is itself supported by a framework of rolled steel sections, well strutted and anchored to the bed of the river. This construction appears to be perfectly water-tight, but a considerable quantity of water finds its way into the excavation through fissures in the hard red sandstone forming the bed of the river. The extent of this leakage may be estimated from the fact that on one occasion when the supply of power for the pumps, which normally keep down the water, failed during a storm, the whole cofferdam, some 35 yards square and 20 feet deep, filled to the level of the river in three hours. Stand-by pumps, driven by oil-engines, have since been installed to prevent a repetition of this

occurrence, in the event of a break in the supply of electricity from the temporary power-station at Ardnacrusha. The folly of relying solely for such important work on a supply of power transmitted for eight miles by temporary overhead lines has thus been demonstrated, and considerable expense has been unnecessarily incurred.

As mentioned in the previous article, the weir is to be built of P.C. concrete, and will be anchored to the bed of the river by steel spikes cemented into boreholes. The object of the arrangement is to prevent sliding of the structure downstream bodily, and this constitutes the most noteworthy point in the design.

The intake building will be provided with sluices to regulate the flow of water into the head-canal. It is sited at right angles to the centre line of the canal, and makes a slight angle with the weir. (*See* Fig. 1). Beneath it is the invert which carries the water from the collecting channel into the Shannon below the weir. The channel will intercept the water, which used to flow into the river, before the construction of the embankments for the storage basin, which have now reached an advanced stage. Unlike the culvert for the Blackwater river, of which a photograph has already been published, this invert has vertical sides and a flattened arch roof, which is heavily reinforced, a 4–2–1 mix of P.C. concrete being used throughout the construction. A catch-pit is provided at the upstream end of the invert.

Fig. 1 shows the general arrangement of the headworks, the cofferdam being indicated by dotted lines. The figure is constructed from sketches made on the spot, and must be regarded as diagrammatic.

(*b*). *Head-canal.*

Ground has been broken throughout the length of the head-canal, and a section about two miles long has been almost completed at the power-station end. In the neighbourhood of Cloonlara, however, scarcely any progress has been made, and an enormous mass of earth has still to be excavated. A great effort will have to be made if the contract date for completion, May, 1929, is to be kept. The broken stone lining of the canal has been begun immediately above the power-station site, and some of the concrete facing at the water-line has been completed. A cross-section of the canal has already been published.

(*c*). *Permanent Power-station Site.*

The work on the Power-station building is going forward very rapidly. Photo 1 shows its appearance at the end of November, 1927. Wooden shuttering is employed, and very large plums are used in the more massive parts of the work. Incidentally, these plums are largely relied on to provide a firm key between parts of the work carried out at different times—a practice which would not recommend itself to all engineers.

The photograph shows the main features of the building, and a close scrutiny reveals the projections to which will be attached the steel pipes taking the water to the turbines. These pipes were erroneously stated to be of reinforced concrete in the previous article, the writer having been misinformed in the matter on his first visit to the works.

The turbine house itself will be built at the bottom of the excavation, indicated in the photograph by the steam shovel at work, in the foreground. The turbine parts are beginning to arrive from the continent, and include some very excellent examples of steel castings.

(*d*). *Reinforced concrete road bridge.*

The road bridge over the head-canal half-a-mile above the power-station has been completed. Photo 3 shows this bridge under construction, with the heavy timber centring still in position.

The bridge, which is of similar design to those to be built for the other roads over the canal, has a very pleasing appearance, and at first sight seems to be of the flattened arch type. Actually, however, the ribs carrying the roadway are not true arches, but curved beams, capable of slight movement in relation to the piers, so as to reduce expansion stresses. The sudden change in the diameter of the piers marks approximately the future level of the water in the canal. The central span is nearly 100 feet, and the width thirty feet.

The most serious trouble experienced during erection was due to bad ground at the northern abutment, which necessitated extensive piling operations before a firm foundation could be secured. The method of supporting the formed portion of the centring on screw-jacks, which can be seen in the photograph in a line on a level with the tops of the piers, is interesting, and must enable a very accurate adjustment to be obtained.

(*e*). *Electrical Transmission Lines.*

Work has begun on the network of high-tension transmission lines, which will in time cover the face of the country, and that connecting Limerick and Dublin is almost completed. A map of Ireland, showing the chief lines and the voltage at which they will be operated, is appended. (*See* Fig. 2).

II. NOTES ON PLANT AND MACHINERY.

(*a*). *Temporary Power-station.*

This station, which was fairly fully described in the first account of the scheme, supplies power to the whole of the works. The plant is said to be very satisfactory in operation, the only serious mechanical trouble experienced being piston seizures; these were finally found to be due to the lubricating oil being kept too long in use, presumably with the idea of effecting a small economy in running costs. The effect of wear in the valve gear is already very noticeable in the

running of the overhead cam-shaft oil-engines, silence in operation being a thing of the past.

SKETCH MAP OF IRELAND.

Showing Principal Transmission Lines.

FIG. 2.

(*b*). *Bank-building machines.*

Photo 4 gives a rather more satisfactory view of one of these very interesting machines than that accompanying the first notes on the scheme. The bank-builders have been evolved from the transporters originally used for winning lignite in the brown coal mines of Germany, and this is the first occasion on which they have been employed in the construction of embankments. It being stipulated that the embankments were to be built up in horizontal layers, the original design had to be altered somewhat for Siemens Bau-union, to whose requirements the machines now in use were manufactured by the three firms, Krupp, Luebecker Maschinenbau-Gesellschaft, and Maschinenfabrik Buckau, in collaboration.

The machine consists essentially of a double-bucket excavator, and two conveyor belts, one movably mounted below the other on a projecting jib. The bucket chains of the excavator, the parts of which are interchangeable with those of the other excavators in use on the works, pick up soil from between the legs of the machine, either direct from the ground or from a dump deposited by railway tip-trucks in a previously excavated trench. The upper conveyor receives the earth from the excavator *via* a hopper, and carries it out along the jib to the lower conveyor, which can be moved bodily up and down the jib, so that the earth falls from it exactly where required. It will be noticed that the slope and reach of the jib have been selected to suit the embankments to be constructed. The motive power is electricity, and the speed and precision of operation truly remarkable.

The bank-builders are mounted on railway trucks, which have to be shifted periodically as the work proceeds. Three lines of track are required, two for the machine itself, and one for the spoil trains; for convenience of shifting they are all laid on the same sleepers.

(*c*). *Arbens-Kammerer Track-shifting machine.*

This exceedingly ingenious device is used for moving the railway track sideways when necessary, and replaces a gang of fifty men with hand-spikes formerly employed for this work.

The machine, the appearance of which is shown in Photo 5, consists of a girder structure supported at its ends on four-wheel bogies. Mid-way between the bogies is an arrangement of flanged rollers, which, by means of a simple screw and lever mechanism, can be made to grip the top flanges of the rails. The track between the ends of the machine can then be lifted from the ground by raising the rollers, and forced any desired distance sideways up to about one foot, the motion being obtained by screws. If the track-shifter is now coupled up to a locomotive and drawn along the rails, the whole track is raised as the machine passes, and is thrust sideways by the rollers. When the track comes to the ground again under the rear bodies, it has been moved sideways by an amount depending upon the lateral displacement of the rollers. Photo 6 shows the apparatus in operation.

The only apparent objection to the method is the repeated lateral bending of the track, which must cause rapid deterioration, especially when flat-bottomed rails are used.

(*d*). *Stone-crushing plant.*

The stone-crushing plant at Ardnacrusha, briefly described in the previous notes, is now in full operation, and a similar plant has been erected near Cloonlara, on the line of the head-canal. The plant at Ardnacrusha, which is electrically driven, is supplied with the waste water from the jackets of the engines in the temporary power-station for washing the stone. The lay-out is compact and convenient, and the product very clean and well graded.

THE SHANNON HYDRO-ELECTRIC POWER DEVELOPMENT.

Photo 1.—The Power Station Building.

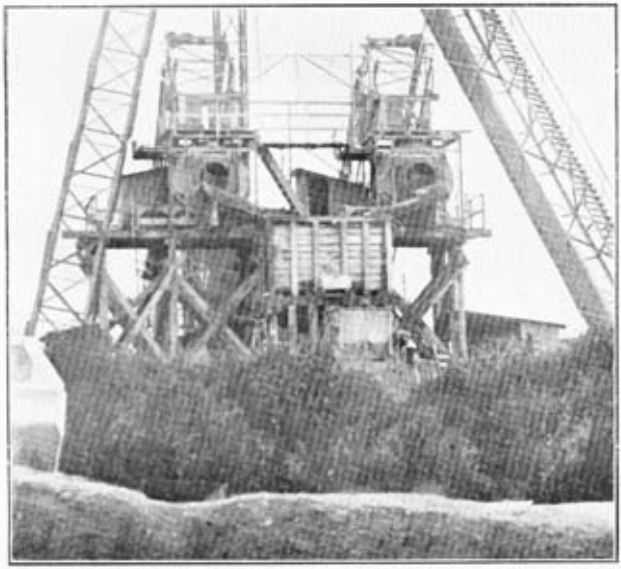


Photo 2.—Concrete Mixing Plant under Cable-crane Tripod.

Concrete Mixing Plant

Photo 3.—Reinforced Concrete Road Bridge under construction.

Reinforced Concrete Road Bridge

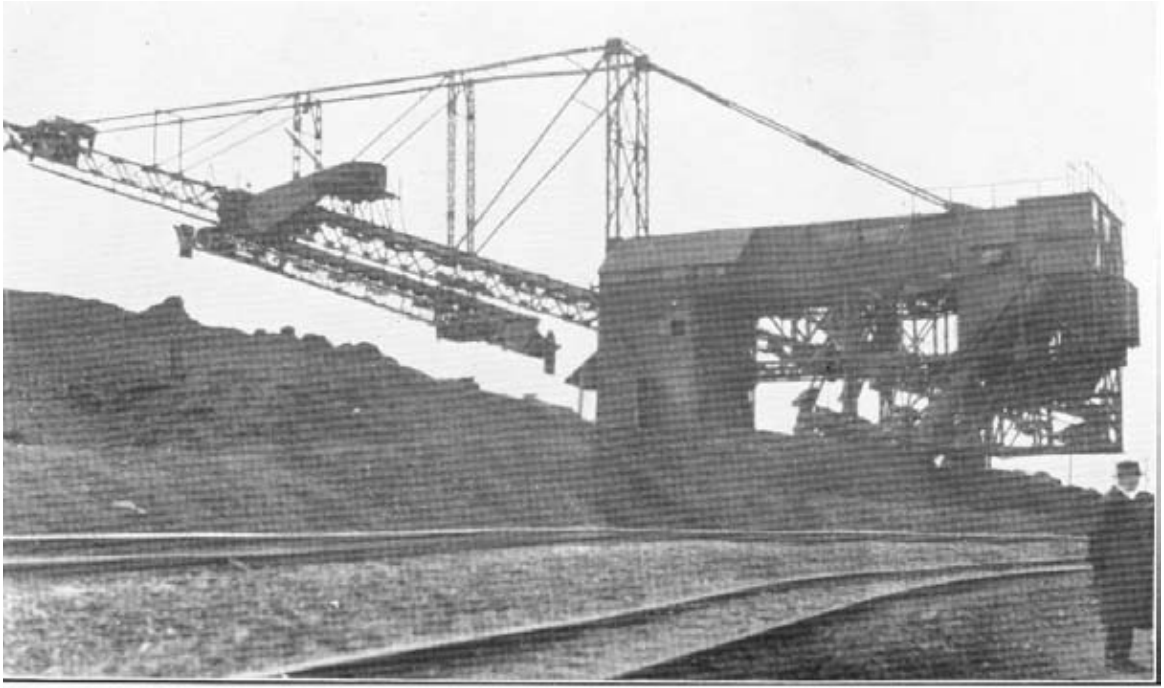


Photo 4.—Bank-building Machine.

Bank Building Machine

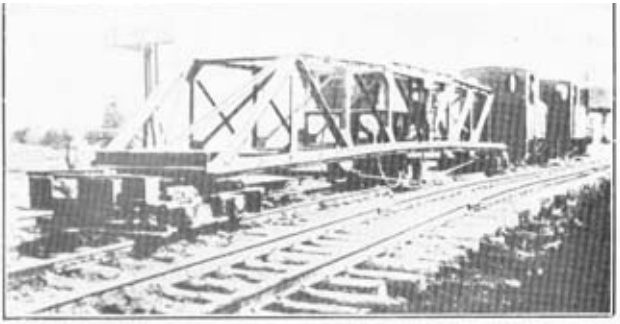


Photo 5.—Arbens-Kamera Track-shifter.

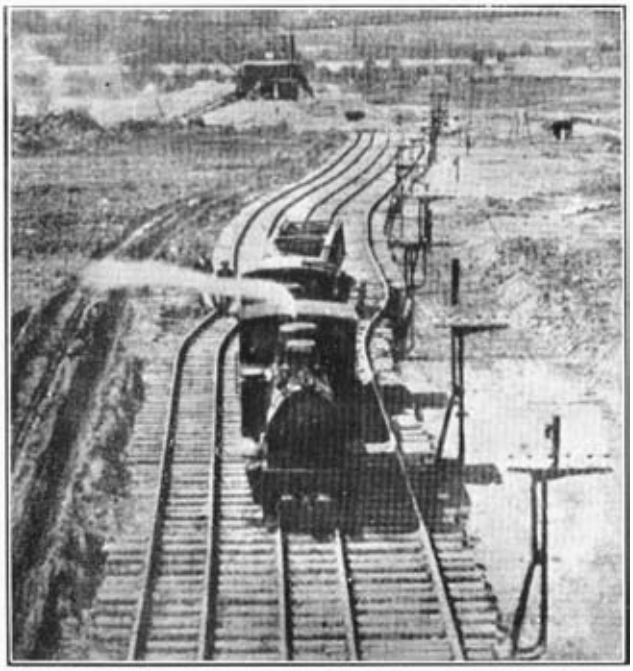
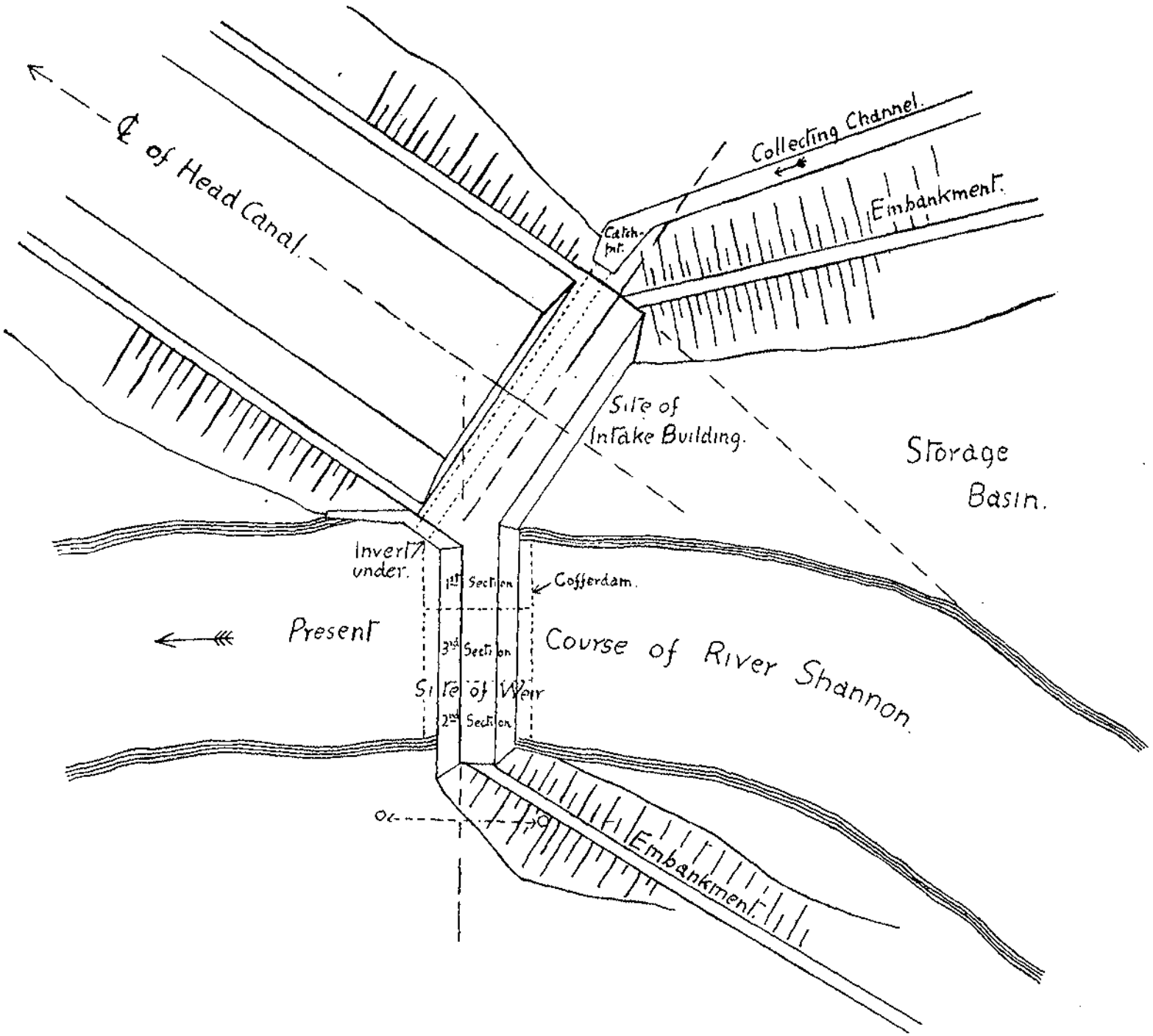


Photo 6.—Track-shifter at Work.

Track Shifter

FIG. 1.—SKETCH PLAN OF HEADWORKS.

Scale: About 50 yards to the Inch.



The weakest link in the chain of operations seems to be the method of supplying the stone, which is drawn in tip-trucks up a ramp by means of a winch. At the time of the writer's visit, the plant could have dealt with stone at about three times the speed at which it was being delivered, in spite of the fact that the gang handling the trucks at the foot of the ramp were working quite smartly. The slow hauling speed accounted for most of the delay, the trucks taking nearly two minutes to traverse the ramp ; it would seem, therefore, that a more powerful winch would do something towards improving matters.

(*e*). *Concrete mixing plant.*

The arrangements for mixing and placing concrete at the power-station site are convenient and ingenious. The two mixers, which are supplied with material by the light railway, are mounted on a platform at the base of one of the cable crane tripods. (*See* Photo 2). The concrete is tipped into chutes, and discharged thence into skips, which the cable crane carries rapidly to any point within its range on the building site. The system depends upon the efficient working of the crane, but this seems to be quite reliable, provided the foremen can be induced to refrain from breaking the main cable by overloading it. The maximum permissible load is about five tons.

III. Concluding Remarks.

(*a*). *The German Invasion.*

The policy of peaceful penetration was one which had a great vogue in Germany in pre-war days, and it is now possible to see it being put into practice in the Irish Free State. Not only is the Limerick district being filled with skilled German artisans and their families, but it is said that estates are being bought up in increasing numbers by wealthy Germans in other parts of the country. Perhaps they will prove more fortunate than the previous owners, who in many cases had their homes burned about their ears. However that may be, one is repeatedly told that they are to be preferred to the British, though admittedly much of what one is told in Ireland has to be taken with a pinch of salt.

The popularity of the Germans on the Shannon workings is undoubtedly on the wane, as is also the reputation for infallibility which the German engineers enjoyed a year ago. It has been found by experience that even the methodical Teuton can make a mistake in levelling, and that having made it, he does not like being chaffed about it. It has further come to light that the German authorities are disconcertingly blarney-proof, and do not show the same admirable propensity for yielding to threats as the traditional British government. But, popular or unpopular, the skilful and industrious German workman is earning better wages in Ireland than he can in his own country, and is not likely to be easily ousted ; for it must be remembered that the energetic and ambitious among the Irish usually emigrate to America.

(*b*). *Commercial and political aspect.*

Some of the difficulties foreshadowed in the last paragraph of the previous article are beginning to materialize. The citizens of Dublin are blessed with a highly efficient steam-power-station, owned by the municipality, which earns a substantial profit in relief of the rates. It is proposed to close down this station as soon as water-power is available, and much ink is likely to be spilt before all parties are satisfied.

In conclusion, the following rough figures for comparison with other schemes may be found of some interest. Owing to the lack of authoritative data on the subject, they must be regarded as a tentative estimate only, and should be accepted with caution.

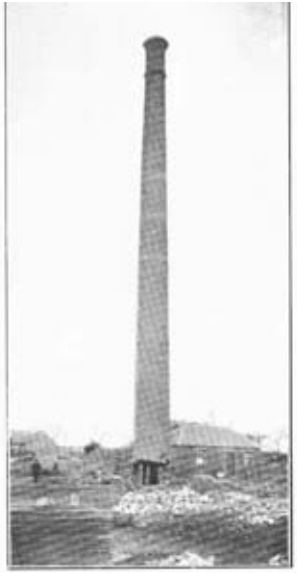
1. *Output.*
   (1) Maximum, (a) Partial development, 56,500 kw.
   (b) Total development, 113, 000 kw.
   (2) Annual, at 30% load factor,
   (a) Partial development, 147½ million kw.h.
   (b) Total development, 295 million kw.h.
   (3) Per head of population, per annum at 30% load factor,
   (a) Partial development, 49·2 kw.h.
   (b) Total development, 98·4 kw.h.

2. *Charges.*

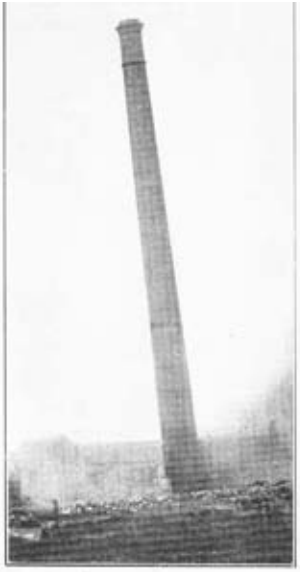
	Partial Development.	Total Development.
Total capital	£8,000,000	£10,000,000
Interest at 5%	£400,000	£500,000
Depreciation, on a quarter of capital at 10%	£200,000	£250,000
Running costs and wages ..	£100,000	£120,000
Total annual charges ..	£700,000	£870,000
Cost per kw.h. generated ..	1·13d.	·70d.

The above figures show very clearly how important a good load factor is to a development of this type, owing to the high capital cost. They also point to the desirability of encouraging the use of electricity so as to enable the total development to be effected.

Special low tariffs will no doubt be adopted for energy consumed during hours when the load is small, with a view to improving the load factor and increasing the number of units over which the charges have to be distributed. By this means the assumed load factor of thirty per cent. may well be exceeded, and the cost per unit reduced in consequence. On the figures as given, the development does not compare very favourably with the best modern steam stations.



No. 2.—Showing the chimney after the various fuses had been lighted.



No. 3.—Shows the commencement of the fall.

No. 4.—A further stage.

No. 5.—Showing the finish of the fall.

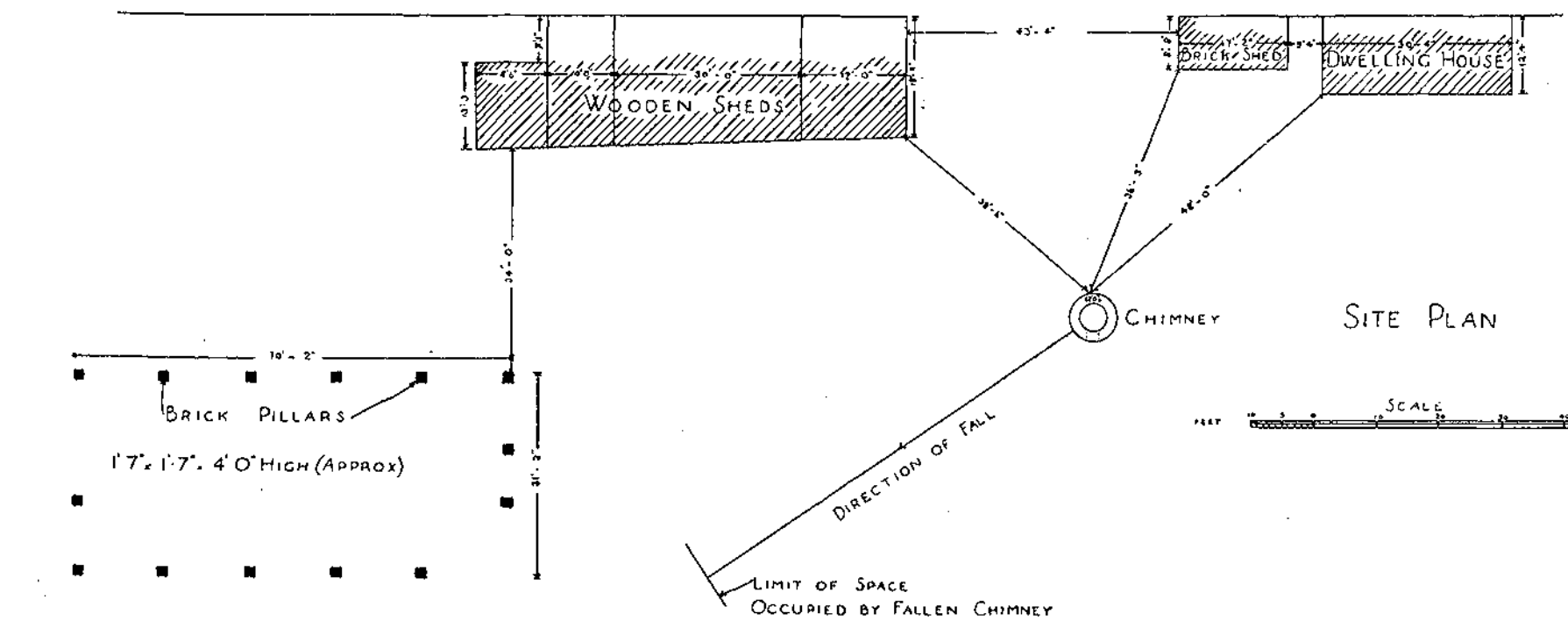
Stages of Chimney Demolition

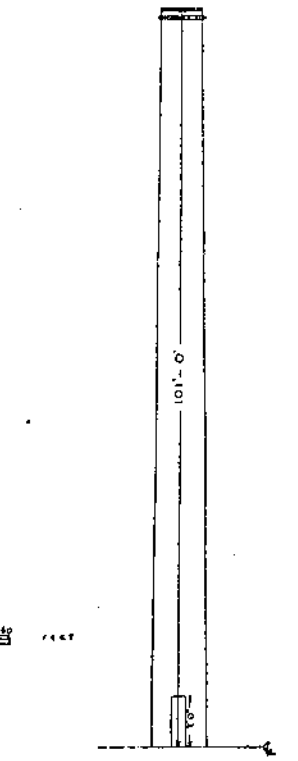
DEMOLITION OF CHIMNEY BY A TERRITORIAL FIELD COMPANY.

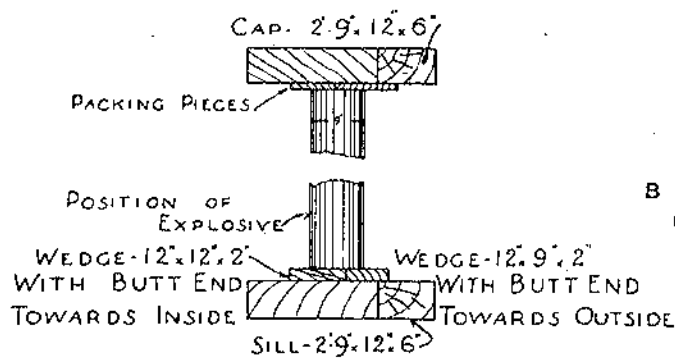
No. 1. View showing arrangement of sills, wedges, props, caps, and packing pieces.

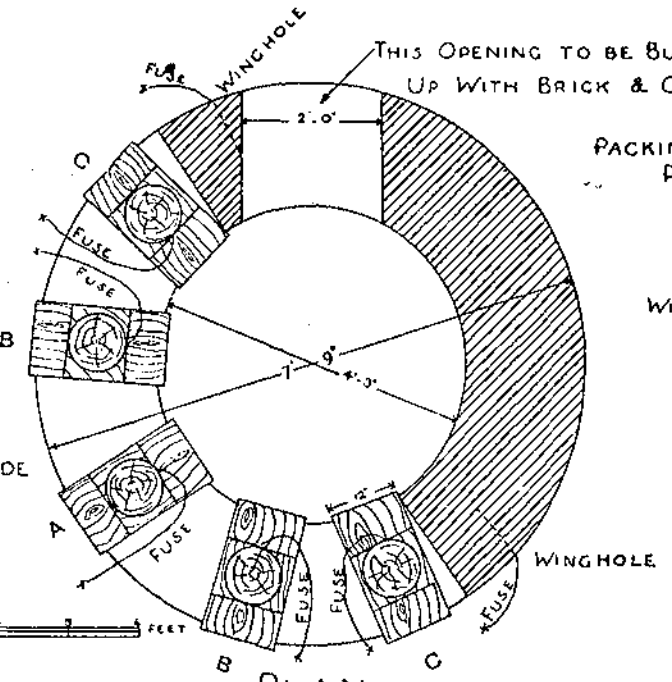
Chimney Demolition by TA

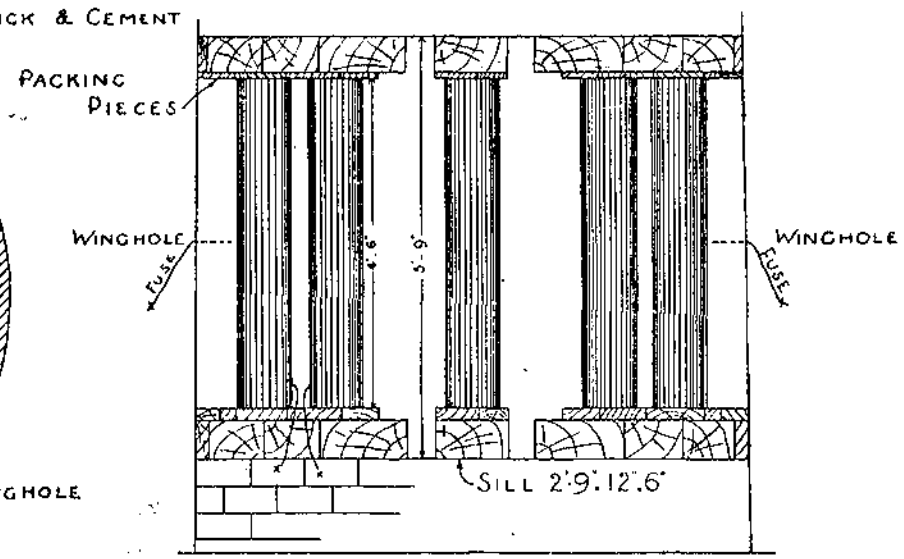
DEMOLITION OF CHIMNEY BY A TERRITORIAL FIELD COMPANY.











DEMOLITION OF CHIMNEY BY A TERRITORIAL FIELD COMPANY.

By LIEUT.-COLONEL H. S. TAWSE, R.E. (T.).

FOR the purpose of annual training in demolitions, the 236th (Highland) Field Company, R.E., T.A., recently demolished a brick chimney at a disused brickyard near Aberdeen. The chimney, which was 101 feet high, was felled by underpinning half the circumference with props, then shattering them with gun-cotton. This was accomplished by starting in the middle of the proposed breach and getting out sufficient brickwork to allow the first prop to be inserted. An additional section of brickwork was then removed to allow the second prop to be erected, and so on until all the props were placed in position. No explosives were used in the underpinning process, as an unforeseen collapse might have taken place owing to concussion.

The props were of larch, 9 in. diameter, and sat on two hardwood wedges, the top wedge being placed with the butt end towards the outside, so that when the props were shattered by the gun-cotton, which was placed about 9 in. from the bottom of the inside of the props, they would be forced outward, and slide off the wedges if not completely shattered. The hardwood wedges were placed on pitch-pine sills, which distributed the weight over as large an area as possible. Caps of similar dimensions were inserted between the tops of the props and the top of the breach, and, where necessary, packing pieces of pitch-pine were used between the props and the caps.

A slab of gun-cotton was placed against each prop, and exploded by means of *cordeau détonant* and safety-fuse. The charges were fired in rotation, starting from the centre of the breach and moving towards each end. The time was regulated by the length of safety-fuse used for each charge, about a second being allowed to elapse between each shot. The fuses and the timing were so arranged that prop A was blown first, then the two props B, and thirdly the two props C, as lettered on the accompanying plan. In addition to shooting out the props, two wingholes were drilled into the brickwork of the chimney at each end of the breach, charged similarly to the props, and exploded last, so that the breach became under the centre of gravity of the chimney, and so caused the collapse of the chimney in the required direction.

The demolition was carried out successfully by Territorial Sappers, previously untrained in demolitions and use of explosives. The direction of the fall was correct according to the line shown on the site plan, and well within the length previously allowed for the fall, which was two-thirds of the height of the chimney.

A RECENT WIRELESS DEVELOPMENT.

By COLONEL F. A. ILES, C.B.E., D.S.O., R. OF O.

THE transformation of electrical into other forms of energy, light, heat, or mechanical energy, are still in the main confined to those cases where the place of origin and the place of manifestation are connected by live-wire. The radiation of energy by Hertzian waves permits us to dispense with the connecting electrical conductor, but the losses of energy are so great that transmission of energy without wires has hitherto not been extended beyond those cases in which the phenomena produced at a distance are achievable by minute currents, that is to say, not beyond wireless telegraphy and wireless telephony, including in the latter its best-known form, broadcasting. In this sense, wireless telegraphy must be understood as including its special case, wireless picture telegraphy and its offspring, still in the experimental stage, electrical vision. In its restricted sense it has these two things in common with wireless telephony, that it is a message-carrier, which works by conversion and re-conversion ; and that for normal working it requires, in order to deliver its message, the assistance of another medium, the air and its sound-waves.

Twenty years before the advent of wireless, the telephone had taught us that the air-vibrations which affect our ears, causing sound, also affect a microphone so as to bring about certain electrical effects, and that these electrical effects are by means of a telephone-receiver re-converted into sound-producing air-vibrations. The fidelity of the imitation would be startling in its realism if use had not familiarized us to the wonder of the telephone. What we hear from the telephone-receiver is none the less a reproduction, as is what we hear from a gramophone, only that, in the former case, the reproduction is instantaneous, and without record. Since electrical phenomena are the agents of this reproduction, and since these phenomena are clearly defined in the world of electricity, it is now possible to produce by electrical means alone that which has hitherto been arrived at only by conversion from sound ; in other words, to *produce* music instead of *re*producing it.

M. THÉREMIN.

Newspapers, in describing the invention of M. Théremin, by means of which this is done, have spoken of " the music of the spheres," or " music from the ether," have claimed that M. Théremin, " himself no musician," was drawing upon something supernatural. These

utterances must be looked upon as the language of poetry. The music played by M. Théremin and his assistants and other experimenters following him, emanates not from the ether, but from the brain of the performer, and is expressed upon an instrument, consisting of wireless oscillating valves actuating a loud-speaker, which is just as truly a musical instrument, as if its music was the product of wind or strings. The proof of this statement lies in an examination of the conditions which M. Théremin's instrument, equally with wind and string-instruments, fulfils. What, then, are those conditions? When the state of equilibrium of an elastic body is disturbed by shock (produced either by impact or by friction), the body tends to regain its state of equilibrium by oscillations on either side of its original position. If these oscillations are of the requisite rapidity (say, more than 16 per second and less than 36,000 per second), air-vibrations are caused which in the human ear will produce sound The principal musical oscillators fall into two main classes, wind-instruments and string-instruments. In the former, the oscillating body is a column of air, in the latter the vibration is of solid bodies, so-called strings, actually of catgut or metal wire. That which is common to both classes is (1) elasticity, a term taken to include the capability of being displaced into a state of unstable equilibrium, and (2) inertia. These two attributes are not confined to musical oscillators: they are the essentials of any mechanical oscillating contrivance, whether sound-producing or not, such as a lath held at one end in a vice, and having a weight fastened to its free end; or a weight hanging by a helical spring. They are equally the essentials of an electrical oscillating circuit. In this case, the counterpart of mechanical elasticity is the interplay of lag and lead in current behind or ahead of potential, as the current charges alternately inductance or capacity: while the inertia is the current-strength, *i.e.*, the mass of the electrons carried. As for the reception of H.F. oscillations by the telephone-receiver, at a frequency of half-a-million, corresponding to a common wave-length, 600 metres, the telephone-receiver will not respond to them, being by reason of its inertia incapable of vibrating at such a speed. In any case, they would be inaudible at a frequency exceeding 36,000 per second, the upper limit of the human ear; and this corresponds to a wave-length of five miles, which is far outside the wave-length range of ordinary wireless stations. For reception the frequency of H.F. oscillations has consequently to be reduced to within the audibility limits. This is best done by the formation of beats.

Beats.

The formation of beats is a well-known phenomenon in sound. When two different notes, *i.e.*, sounds of different frequency, are sounded at the same time, one with a frequency of m per second, and

the other with a frequency of n per second, they alternately strengthen and, owing to "interference," weaken each other, the combined sound rising to a maximum with a frequency of $m-n$, *i.e.*, there will be $m-n$ beats per second. A similar effect is observed with alternating currents, and also with H.F. oscillating currents. This formation of beats furnishes an easy means of rendering audible H.F. oscillations which occur above the range of audibility, since beats or maxima in the amplitude of the total current are formed when two H.F. oscillating currents of slightly different frequencies are superimposed. The frequency of the beat is arranged so as to produce a musical note in the telephones.

Beats are, however, met with, which are both unmusical and unintentional. The whistles and shrieks familiar to all listeners-in to broadcasting are beats caused by the combined effect of a wireless valve-receiver accidentally starting to radiate, while the broadcasting station is working. If a receiving-station inadvertently sets a valve oscillating so as to affect its own aerial, radiation takes place, and the case occurs of two frequencies being superimposed. If the beat thus produced is of a frequency between 10 and 70 per second, the noise made is very unpleasant, the maximum of dissonance being reached at about 30 beats per second.

Although the idea of music from wireless was no new one, dating as it did from 1900, and Duddell's Singing Arc, a precursor of the valve in producing continuous waves, it remained for M. Théremin to show how beats could be utilized for producing pleasing sounds according to plan.

APPARATUS.

In the first place, the instrument appears to include two valve-oscillators, normally of the same frequency. One valve is in a circuit of fixed frequency; the frequency of the circuit containing the other is variable, for the purpose of creating beats. The frequency of an oscillating circuit varies when either capacity or inductance is altered. M. Théremin changes the frequency of the beats between his two oscillating circuits so as to make musical sounds, and he does this in an original manner. The use of an upper and lower capacity, instead of aerial and earth, is well-known in wireless. It was the aerial equipment of early wagon-sets in the British Army. M. Théremin makes his valve, the frequency of the oscillations of which are to be varied, charge a capacity of which the upper portion is a metal rod and the lower portion is himself. The apparatus is sufficiently sensitive for a movement of his hand towards or away from the upper capacity (called by the newspapers the "antenna") to alter the strength of the field of electric strain between the two capacities, hence the total amount of "capacity" in the circuit, hence the frequency in the one circuit, and a beat is formed with the oscilla-

tions of unvarying frequency in the circuit of the second valve. The beat thus formed is musical according to the performer's skill, and, by varying it, he is able to play tunes.

A third valve, coil-coupled to each of the first two valves, acts as a detector, by passing the superimposed oscillations through a transformer to the telephone-receiver or loud-speaker. Simple musical notes are thus obtained, but a great deal more is necessary before a performance can be given, and these additional requirements have also been tackled by M. Théremin with success.

As regards variations of intensity or loudness, these are done, in a much more mysterious manner, by the performer's other hand approaching or receding from a horizontal metallic ring known as the " power " antenna, to distinguish it from the " musical " antenna, the metal rod mentioned above. This hand, like the other, moves freely in the air without touching anything. It would, therefore, appear to work also by affecting capacity, but there is this great difference, that in the first case frequency is changed by change in capacity, while in the second case the circuit must be guarded against change of frequency by means of a stabilizer, in order to allow control over amplification.

As regards quality of tone, or *timbre*, M. Théremin has, in order to improve it, pressed into his service yet another source of trouble in wireless, viz., the formation of harmonics. This phenomenon, well understood in the study of sound, applies to H.F. oscillations equally as to taut strings, and has helped M. Théremin to imitate wind instruments, string instruments, and even the human voice.

Without going into the musical possibilities, either singly, orchestrally, or from a composer's point of view, of this latest achievement of that " wonderful lamp," the valve, it can safely be said that very great skill and judgment are required for a good performance on M. Théremin's invention, and this because, there being no keyboard, the performer must perforce play on imaginary keys. This difficulty has, however, already been got over by an improvement due to M. Bertrand, who, with an instrument on similar principles, has provided a keyboard in the shape of a semi-circular dial, upon which a movable pointer can be made to move in and out and to describe an arc of 180°. For any given piece of music, the dial can also do duty as score, since the positions of the notes can be marked beforehand, and straight lines be drawn joining these positions, to show the order of playing. There may well be a future for this instrument, in which but small skill on the part of the performer appears to be necessary.

FORCED PASSAGE OF A RIVER BY MECHANIZED FORMATIONS.

By DR. OSKAR REGELE, Major, Vienna.

MECHANIZED formations are already included in certain armies amongst the regular arms of the service. These formations are entirely mechanized, and comprise no cavalry, infantry, nor horse-drawn transport.

The transport of a mechanized formation is formed of different types: motor cycles, motor cycles with side-cars, motor vehicles of all types and dimensions for personnel—together with motor lorries, mechanized artillery (hauled and self-propelled guns), pioneer and telegraph detachments, and, lastly, tanks of various types.

The principal mission of mechanized formations is rapid movement over great distances. No obstacles should, therefore, delay these vehicles very long, otherwise the advantage of speed is lost.

If mechanized formations are in reality to constitute a very mobile striking force, with which hitherto-unheard-of successes may reasonably be expected, it must be possible to use them at any point and over wide stretches of country.

Impassable mountains and rivers form two of the chief obstacles to be encountered by motor vehicles. Whereas, at present, impassable mountains absolutely preclude the employment of mechanized units, rivers may be crossed with the help of the Engineering Sections. In future, rivers will be of special importance in battle (operations), since they afford mechanized units very effective opportunities of defence. If, however, these units should not be capable of crossing rivers in face of the enemy, the value of these formations would be greatly reduced.

Mechanized formations must, therefore, be fully equipped and trained, to enable them to force the passage of rivers.

We will not at present consider the possibility of the use of swimming tanks. In their present form and technical development, they have not sufficient tactical mobility to cross a river held by the enemy, independently. The taking off and landing of these swimming tanks is a very laborious and slow operation, affording the defenders a good opportunity for well-aimed fire. An enemy equipped with good anti-tank weapons could very easily destroy attacking swimming tanks.

If, however, a mechanized formation is not equipped with swimming tanks—which might, at times, succeed in crossing a defended river—an important question arises: how can a mechanized formation succeed in forcing the passage of a river in face of the enemy?

The problem of Artillery support is quite simple, as the method by which this artillery reach their fire positions on the other bank is immaterial. Nor need we enter into the question of air protection, which is indispensable in all river crossings in contact with the enemy, since this is organized by the Air Service itself.

But what troops should form the first assaulting units in the passage of the river? Here it is obvious that a mechanized formation must have at its disposal "light" units to lead the way across to the bank occupied by the enemy—infantry with a large number of M.G.s, anti-aircraft and anti-tank guns, light guns, cyclists. The task of these light units—which should lead the attack crossing the river in light pioneer craft (small boats)—is to occupy and hold a bridgehead on the further bank; heavy mechanized units can then be transported under their protection. It is impossible to convey motor cyclists, self-propelled artillery, or tanks—even if comparatively small and light—amongst the first units to the further bank. In consequence of their slow movements during shipping and landing, their large target-surface and great weight—they would be incapable of effecting the so-called "assault crossing," in which assault troops land quickly, carry their weapons without special difficulty, and do not increase the difficulty of the pioneers' work, as they row under enemy fire.

Should the light fighting forces succeed in occupying a bridgehead, their first care must be to secure the position against tank attacks by emplacing anti-tank weapons, for a skilful tank attack upon an enemy recently landed would, in any case, be most dangerous. Since, however, the halt at the bridgehead must be as short as possible—to avoid giving the enemy time for counter-measures, the troops required to follow up the attack upon the enemy must be brought up without delay. The transport of heavy mechanized units must, therefore, begin at once. This will only be practicable if the said units have at their disposal a large number of well-trained pioneers, with modern equipment. The transport of motor vehicles, guns and tanks requires a first-class pioneer unit. The successful exploitation of mechanization in battle, and during river operations, is entirely dependent upon the Pioneers, who go first and remove all obstacles which would impede the action of these vehicles.

In consideration of modern air warfare, which facilitates effective attacks upon military bridges, and since experience proves the impossibility of camouflaging them—it is advisable to avoid constructing them, and to concentrate upon ferrying. In future—and especially in daylight—it will be almost impossible to construct

bridges, unless a force possesses overwhelming superiority in the air.

Even in the case of smaller streams, which might be crossed by ordinary tanks, it will be advisable to move light units first of all to the further bank. The very excellent bridging-tanks, which have proved so valuable (pioneer tanks, bridging wagons), can only extend their bays very slowly, and cannot carry out this work in face of the enemy without protection from their own guns. All motor vehicles which have to overcome lesser obstacles are obliged considerably to reduce their speed for this purpose; they must frequently halt for some moments, and—their accuracy of fire being decreased by the oscillation of the vehicle—thus afford favourable targets to the observant enemy.

The following conclusions may be stated as a result of the above considerations :—

(1). Mechanized formations, when forcing the passage of rivers, must have at their disposal light units, and also light pioneer equipment—transported, of course, in motor lorries —to enable them to form active and very mobile assault units.

(2). The bridgehead occupied must be effectively protected against tank attacks, until the tanks (and artillery) of the force in question arrive.

(3). Ferrying is always preferable to the construction of bridges.

(4). The number of pioneers available must be sufficient for the rapid transport of all sections of mechanized troops to the further bank. The pioneers must themselves be very mobile, in order to avoid any delays.

(5). The possibility of crossing rivers quickly and safely is one of the chief conditions for the successful employment of mechanized formations in future warfare

THE CAMBRIDGE UNIVERSITY EAST GREENLAND EXPEDITION, 1926.

By LIEUT. P. F. WHITE, R.E.

BY the year 1926, the whole of the coasts of Greenland had been visited and surveyed, with the exception of a strip on the East Coast between latitudes 72° 00′ N. and 74° 30′ N. Between these latitudes lie, perhaps, the most interesting parts of the whole coast, including, as they do, the wonderful system of fiords discovered and surveyed by the Swedish Expedition in 1899. Although this and other expeditions had sailed as far inland as 100 miles from the sea, ice conditions had in all cases prevented them from landing on the outer coast.

The existing map of this coast was based on that made by William Scoresby, a Liverpool whaling captain, who, during the summer of 1822, made what has proved to be an extremely accurate survey of what he saw. Unfortunately, with the solitary exception of the region near Cape Simpson, on Traill Island, he never saw the actual coast at all. His work was carried out with a sextant from the crow's-nest of his ship, which could get no nearer than from 20 to 30 miles from the land. Much of this coast has a low-lying foreshore, stretching back sometimes as far as a mile to the foot of the mountains. That it was these mountains that Scoresby saw, and called Capes, is shown very clearly by comparing the excellent panorama he drew with photographs taken from positions closer in to the shore.

It was for this part of the coast that the party of eight members of Cambridge University left Aberdeen on June 30th, 1926, in the sealing ship s.s. *Heimland I.* Our leader, Mr. J. M. Wordie, M.A., (St. John's), had already, in 1923, attempted a similar expedition, but bad ice conditions had made it impossible to reach the coast, although within sight of it. (Two Sappers, R. H. Maclaren and C. C. Duchesne, went with this party.) Lars Jacobsen, the captain and owner of the ship, had with him a mate and a crew of eight Norwegians, who were as fine and helpful a lot of fellows as one could ever hope to meet. Our ship, steam-driven, but whose sails added an extra two knots in a good breeze, was extremely seaworthy. We all felt, however, that we should have preferred rather more than our 64 tons displacement, during the storms encountered on the homeward voyage.

The expedition set out with the following objects :—

1. To carry out pendulum experiments on Sabine Island, a place where similar experiments had been carried out in 1823 by Capt. Sabine, R.A., a member of Capt. Clavering's party.
2. To carry out a topographical, geological, and ethnological survey of the coast between latitudes 72°00′ N. and 74° 30′ N.
3. To locate, and, if possible, climb, Mt. Petermann, supposed by its discoverers, the German Expedition of 1870, to be the highest mountain in Greenland.
4. To send daily weather reports by wireless, and, if time permitted, to carry out some short-wave experiments with people in England.

We sailed first for Jan Mayern, by the Fair Isle passage, hoping to be able to land. Thick fog, however, preventing this, we established wireless communication, and made the necessary arrangements for them to listen morning and evening for our weather reports. Soon after leaving Jan Mayern, we met the edge of the ice, and followed it up to lat. 75° N. before turning westward. Within a few hours of entering the pack, we shot our first seal, so that, except for one week, we lived on fresh meat the whole trip. The ice proved exceptionally open. We tied up one night to an ice-floe to replenish our stock of fresh water from the pools on the floe, and to wait for fog to clear. On July 12th, within two and a half days from the time we turned into the pack, we came close to land in the fog. Next morning, when the fog cleared, we found we had anchored under the cliffs of Little Pendulum Island in one of the places recommended as a good anchorage by the "Arctic pilot." During our first evening on shore, we shot three brace of eiderduck, and the crew collected about 250 of their eggs, which made a very welcome addition to our larder.

As it had been impossible to make any exact plans before we knew when and where we were going to reach land, we now decided that, while the pendulum experiments were being carried out, we should give ourselves and our equipment a trial run on Sabine Island. This was invaluable, as it introduced us to the walking conditions which we were to meet throughout the trip, and gave us a good idea of what sort of loads we could conveniently carry. Walking in these parts is extremely tiring, as the ground is covered with loose stones. The hillsides are also mostly "scree," lying at its maximum angle of repose. There was never any danger of an avalanche, but, in climbing, one's feet slipped back a few inches at every step. In descending, this became an advantage, as one could run down for long distances : as much as 2,500 feet of descent could be accomplished in half-an-hour.

The sun had not set since July 3rd, so that time became a matter of indifference. We had our breakfast at 3 o'clock in the afternoon,

if we had not found it convenient to go to bed before 6 a.m. At our first camping place we found an excellent pool, and bathed at midnight, drying afterwards in the sun (temperature about 50° F.).

Our tents were extremely good. They had a floor area of about 8′×8′, which was ample for two people in sleeping bags, and their total weight was about 13 lb. Our sleeping bags were of reindeer skin with the fur inside. Our only other special equipment was a suit consisting of trousers and pullover jumper, made of a light "windproof" material which had been tried out by the last Everest expedition. We found them invaluable when working on the top of a mountain, with the wind blowing. They were amply big, and were pulled on over our other clothing when required.

We were not troubled at all by cold. The general shade temperaature was between 32° F. and 40° F., but went up to 60°—70° in the sun. After any strenuous climb we frequently undressed and bathed in the snow. On two occasions we bathed in the sea. Apart from this, our ablutions were very scanty, and, fortunately, not very necessary.

Just as the pendulum experiments had been finished, we had our one and only experience of an Arctic blizzard. Two of us were alone on Sabine Island, the remainder of the party having gone off in the ship in an attempt to sail round the north of the islands. At 9 a.m., we woke up to a calm, clear morning, and went to sleep again. By 10 a.m., a gale, estimated at 60 m.p.h., was blowing sleet upon us. The tent containing the pendulums was wrecked—fortunately without damage to instruments. Luckily, we saw the humour in the situation as we cooked our breakfast of porridge and pemmican on a "Primus" stove, while sitting in an ever-increasing pond, formed by the water dripping through the tent on to our absolutely impervious waterproof sheet. Breakfast finished, we packed up everything and moved into a wooden hut which had been built a few years previously by some trappers who had wintered there. The blizzard lasted for three complete days, and, to our great relief, the ship reappeared on the fourth evening. This experience might have ended far from happily, had not the Captain sensed the coming storm, and run the ship under the lee of Little Pendulum Island, for the dinghy left with us was washed away one night during a particularly high tide.

During their absence, the rest of the party had shot a walrus and two bears. A third bear, Susie, who is now in the Zoo, had been lassoed in the sea, and was in a crate on board.

Our next objective was the country round Clavering Island. Here we started our survey in earnest, and made our first important discovery, which we named Granta Fiord. In this neighbourhood we met musk oxen for the first time. After an all-night hunt we shot five, and spent the next twelve hours bringing the very welcome meat to the ship. The surveys of this neighbourhood being com-

pleted, we set off south past Hold-with-Hope into Franz Joseph Fiord, with the object of attacking Mount Petermann while the weather was fine.

Franz Joseph Fiord presents wonderful views throughout its length of 100 miles. Generally about three miles across, its sides, bare of vegetation, and banded with the different colours of the various strata of rock, rise very steeply to an average of about 3,000 feet. Icebergs from the glaciers which feed the fiord abound and add extra charm to the scene. The head of the fiord is the finest of all, for here the mountains all rise to over 6,000 feet, and yet, owing to the large scale of the whole surroundings, do not appear to be half that height. The mountaineering party, after climbing 7,000 feet, found that Mt. Petermann was more than 20 miles inland, and that its ascent would be impossible in the time they had allowed themselves. They were, however, able to locate it definitely and, in addition, to discover another peak (about 11,000 ft.)—named Mt. Shackleton—which, we believe, to be higher than Mt. Petermann. There was, for these parts, quite luxuriant vegetation at the head of the fiord up to nearly 2,000 feet : bilberries, dwarf willows and harebells being commonest.

Before returning to the outer coast, we made a short stay in Musk Ox Fiord, in order to connect up our survey with that of Loch Fyne. Here we caught, in a net, a young musk ox, which soon became very tame, and wandered about the ship very happily. She, also, with Susie, was given to the Zoo.

I also managed to shoot the only large male bear we met. He appears to have been quite alone, as we did not see any more until we were 100 miles away.

Fog now put an end to the spell of about 150 hours of continuous sunshine which had attended us in the Fiord, and held us up for three very precious days. The fog did not extend higher than about 1,500 feet, and above this there was always a cloudless sky. It was when above the fog one evening that we saw our shadows on the fog below, surrounded by an aurora consisting of five concentric rainbow circles: a most curious and pretty effect which is discussed by Scoresby.

After a short visit to Jackson Island to finish off the coast of Hold-with-Hope, we started on our last lap—the coasts of Geographical Societies Island and Traill Island. As time was getting short, we worked in two relays throughout the 24 hours. By this means we were able to finish off the outer coast, but had to leave only partially complete the head of Mountnorris Inlet in Traill Island. Thanks to the absence of ice, we were able to land wherever we wanted, and so make a more accurate survey than had ever been possible before. We reached Mountnorris Inlet on August 21st, and as the weather appeared about to change we sailed south the next day. During the last week, we had been observing some beautiful effects of combined

sunset and sunrise, about midnight, the former slowly merging into the latter.

Before returning home, we decided to visit the Eskimo Settlement in Scoresby Sound. Although we saw ample traces of previous Eskimo habitations in the country we visited, they all, for some unknown cause, have died out. The Scoresby Sound Settlement is an attempt on the part of the Danish Government to repopulate this district with pure-bred Eskimo from Angmassalik farther south. At the Settlement we met the Danish explorer, Dr. Lange Koch, who has travelled very extensively in Greenland, and who was now at the start of his winter stay, during which, in the spring of 1927, he made a 1,200 mile sledge journey to Denmark Haven (lat. 77° N.) and back.

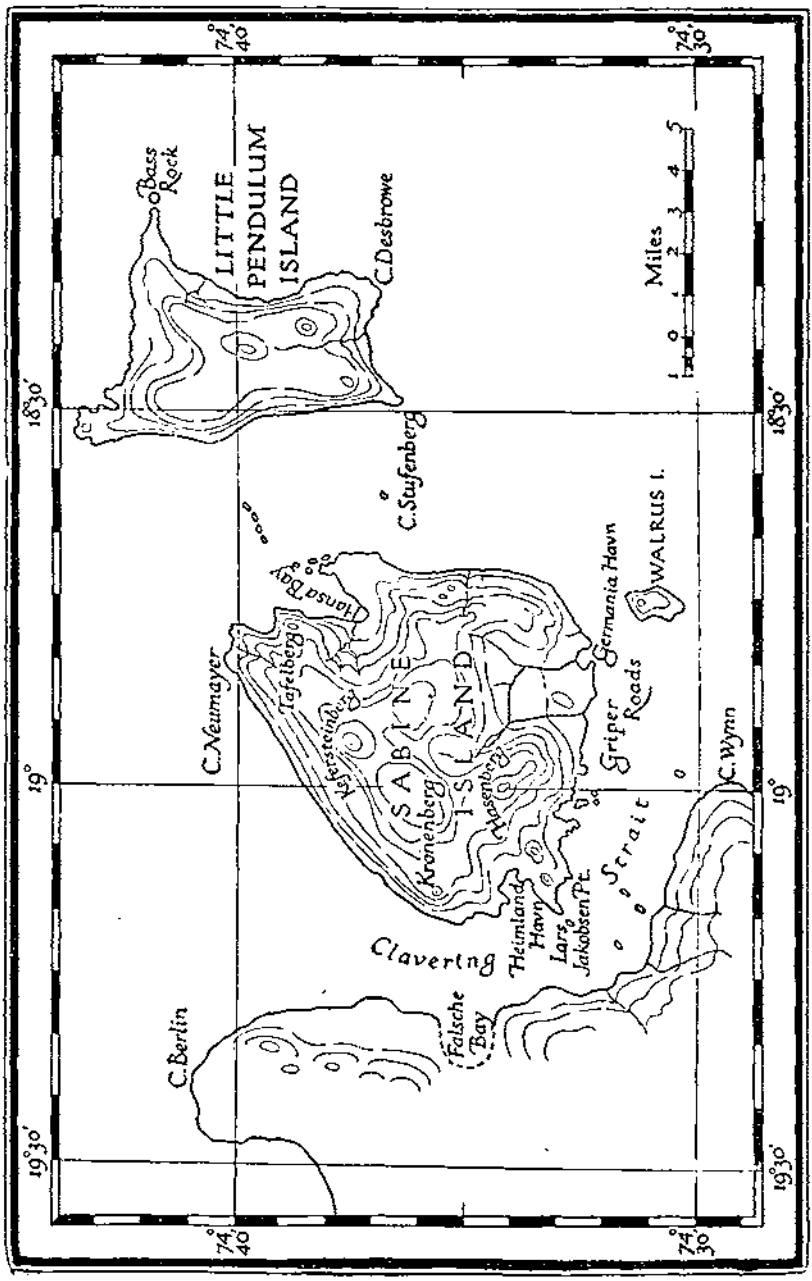
A storm delayed our arrival at Reykjavik, the capital of Iceland, and kept us in harbour for four days. For the whole of this time we received the greatest hospitality from the British Consul, who arranged several interesting trips for us on the island.

Soon after leaving Reykjavik, we encountered another storm, which drove us north of the Faroes. Three times did the sea come over the stern of the ship, breaking the cabin skylight and dislodging everything aft. The crew collected seal skins and bags of straw soaked in oil, which they trailed behind the ship, and which prevented the waves from breaking over us more often.

We had to call at Lerwick, in the Shetlands, to take in water, so it was not until Sept. 8th that we finally reached Aberdeen harbour, having been absent ten weeks, and all sincerely regretting their termination.

The results of the expedition were laid before the Royal Geographical Society by Mr. Wordie (*Geographical Journal*, Sept., 1927), and the scientific side discussed. They may, however, be summarized briefly. The Pendulum results were very satisfactory. The unmapped portion of the sea coast was mapped with an accuracy quite sufficient for the purpose, and as great as could be expected with the instruments and time at our disposal. Signs of past Eskimo occupation were found wherever we landed, though none of recent date. (Living Eskimo were last seen here in 1823 by Capt. Clavering, R.N.) We found numerous winter houses, tent rings, and meat stores, also a few fox traps. We excavated three graves, and brought home the skeletons. With very few exceptions we sent out weather reports twice daily to Jan Mayern, who forwarded us an occasional message from home. We had no time to try any short-wave wireless experiments. These, fortunately, were relatively unimportant.

Although our time was very fully occupied, we managed to get quite a lot of shooting. Our bag included ten bears, musk oxen, two walrus, seals, hares, ptarmigan, and eider duck. All the bears, except one, we met on the coast; we saw one on the pack ice, but failed


74° 40'
74° 30'
18° 30'
19°
19° 30'
Bass Rock
LITTLE PENDULUM ISLAND
C. Desbrowe
C. Stufenberg
C. Neumayer
Hansa Bay
Tafelberg
Kronenberg
Hasenberg
SABINE ISLAND
Germania Havn
WALRUS I.
Griper Roads
C. Wynn
Strait
Heimland Havn
Lars Jakobsen Pt.
Claverling
Falsche Bay
C. Berlin
Miles
0 1 2 3 4 5

Midnight Camp, Sabine Island.

Party on Trek.

Panoramic View of Granta Fiord.

THE CAMBRIDGE UNIVERSITY EAST GREENLAND EXPEDITION, 1926.

Panoramic view of Granta fiord

Eskimos in Kayaks.

Eskimos at Scoresby Sound.

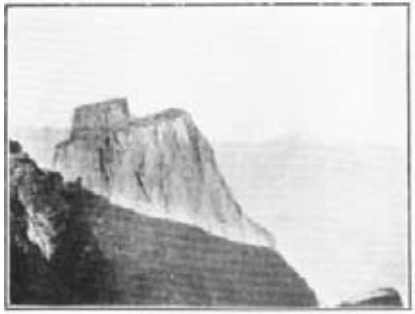
Musk Oxen in Granta Fiord.

Payer Spitze.

Payer Spitze

ss. Heimland I. off Walrus Island.

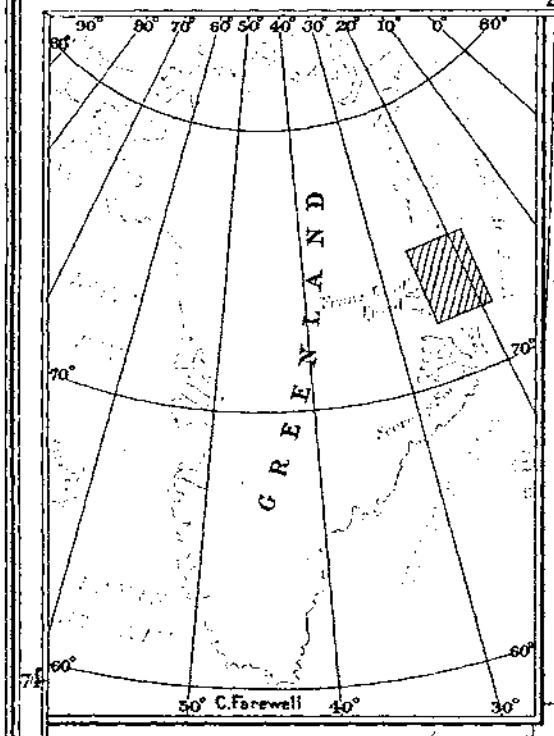
Ridderborgen (6,000 ft.).



Ridderborgen.

View from Summit of Ridderborgen.

Ridderborgen



24° 22° 20° 18°

74°

Farseway How
Scotstounhill 3650
Red I.
Jordanhill 4200
5000
5560
C.Ehrenberg
C.Oetker 3800
C.Blosseville
CLAVERING ISLAND
4000
C.Stosch
Finsch Islands 1000
500
3900
C.Berlin
C.Neumayer
2243
Bass Rock
Little Pendulum I.
C.Desbrowes
Sabine I.
Walrus I.
WOLLASTON FORELAND
C.Wynn
C.Berghaus
C.Breusing
C.Borlase Warren
1800
C.Mary

73°

Great Valley
5800
4000
STRINDBERG PENINSULA
Ekstroem's Pass
C.Weber
Devil's Castle
YMER ISLAND
GIESECKE Mts
3000–4000
3400
C.Franklin
C.Grash
Wijkanders I.
C.Humboldt
Robertson I.
Broch Islands
Ruth I.
Maria I.
Ella I.
GEOGRAPHICAL SOCIETY ISLAND
Mt. Lapisce 4800
Mt. Leitch 3000
Mt. Freycinet 4500
Scott Keltie Islands
C. Hovgaard
Nordenskiöld I.
C.Palander
TRAILL ISLAND
(2000–3000)
C.Petersens
Craig Is.
4000
Jackson I. 1350
C.James
1000
C.Kraus
Arundel Is.
HOLD WITH HOPE
Ladder Mountain
Holland I.
2500–3400
C.Broer Ruys
3000
300
C.Bennett
Bontekoe I. 1100
C.Mackenzie
C.McClintock
Franklin I.
4500
C.Parry
Cleft I.
C.Young
C.Mawbura
C.Moorsom
C.Simpson

73°

72°

24° 22° 20°

The Coast Region of EAST GREENLAND between Davy Sound and Little Pendulum Island.

From surveys by G. Manley and other members of the Cambridge Expedition, 1926, under the direction of J. M. Wordie; with the mapping of earlier explorers shown in outline.

Scale 1/1,000,000.

10 5 0 10 20 30

Approximate heights in feet 5560
Rougher heights in feet 3000

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EAST GREENLAND.
Wordie.

to shoot it. Seals were plentiful everywhere, and we only shot them for a change of diet. We saw between two and three hundred musk oxen altogether. Like bear, they are very poor shooting, but, in both cases, the meat is excellent. The musk ox, apparently, can see only about ten yards, but their sense of smell is very keen. Bears, generally, take to the water, where they are easy prey. Our most exciting hunt was after a walrus, which, after being pursued for half-an-hour in a dinghy, was eventually harpooned by the captain. All the fat and the meat we did not require immediately was salted and put into barrels as a winter supply for the crew.

In conclusion, we all agreed that the scenery alone, from the first sight of the pack ice until the last, was almost worth the trip. Of the fiord type, this particular area, which is unique on the east coast of Greenland, must offer scenes without parallel anywhere in the world. Photographs cannot give any true idea of the beauty, as the colouring and vastness of the scale are essential features. Our chief regret was that we did not have time to explore King Oscar Fiord and its tributaries. The effect of refraction was very pronounced and beautiful. Icefields became rows of towers and minarets, with the whole inverted above them. Reflections of distant mountains were also seen upside down on the tops of the originals. This refraction proved very valuable in the survey as points below the horizon were so refracted that they became visible. Apart from super-mosquitoes in one or two isolated places, we had no minor worries, and were all extremely fit, breathing, as we did, air containing no germs of disease.

It is hoped that the foregoing remarks will encourage those who may get an opportunity to visit these or similar parts. There is still plenty of scientific work left to be done, and there are few finer places in which to take a holiday.

RECREATION GROUNDS.

THEIR CONSTRUCTION AND MAINTENANCE.

By BT. LIEUT.-COLONEL G. B. O. TAYLOR, C.B.E., R.E.

Now that recreation grounds are authorized for the soldier, it is incumbent on the R.E. officer to have a working knowledge of the methods required for their construction, and of their maintenance.

Although the State does not normally maintain the grounds it provides—*vide R.E.S.*, para. 432, and Table L—it may happen that, in exceptional cases, such as when barracks remain empty over a season, it becomes necessary to do so in order to prevent these grounds falling back so seriously in condition as to necessitate reconstruction.

The actual scales of provision are laid down in *Barrack Synopsis*, and it will be seen from a study of these that the work required, from the engineering point of view, divides itself into three well-marked categories :—

(1) The provision of a playing area for football and cricket.
(2) The provision of tennis courts and cricket pitches.
(3) The provision of a running track.

Each of these requires different consideration and treatment.

(1) AREAS FOR FOOTBALL AND CRICKET.

It will seldom occur that available ground will be found sufficiently level and well grassed to enable it to be taken into use forthwith, and the first step is usually, therefore, to level an area of the extent required.

LEVELLING.

A football ground or the outfield of a cricket ground need not be dead level, in fact there is a considerable advantage to be gained in throwing precipitated moisture off quickly by having a gentle slope.

This slope, however, should not exceed 1/100 longitudinally, or 1/40 across the playing field, otherwise the slope will materially affect the play.

Cricket pitches, tennis courts, and running tracks, must be dead level, and it is desirable that areas devoted to hockey should be so also, although it should be noted in this connection that the State does not provide playing areas specifically for hockey.

When levelling is resorted to, the first step is to remove all turf from the surface. Any portions fit for re-use should be cut in proper fashion, *viz.*, in strips of suitable size, and rolled up or stacked grass inward, in some convenient spot.

The most convenient size for turves is a matter of opinion, but whatever the size, it must be uniform.

The best is probably one foot square by 1½ in. thick, which is easily handled, and is better in every way than the three feet by one foot turves so frequently employed.

The latter have to be rolled, and, however carefully cut, there are certain to be irregularities which are fatal to the accuracy required in some instances.

Although such irregularities roll out, it is obvious that even consistency of soil, and therefore of growth, are no longer assured, and whereas before there was irregularity of surface, there is now unevenness of texture.

With a large playing area this is of minor importance, and the greater speed of laying of the 3 ft. by 1 ft. turves may render their use desirable.

Levels should then be taken over the area, and pegs put in at five-yard intervals, adjustment being made for any permissible slope given to the final surface.

The exact method of levelling and removing surplus soil, if any, depends on the nature of the soil, and the amount of excavation necessary, but every effort should be made to balance cut and fill, allowing for a final settlement of at least 15% in the fill.

The amount of soil required is largely a matter of opinion—where suitable turf existed before levelling it may be assumed that there is sufficient soil, and, whatever the sub-soil, all that is necessary is to ensure that the top spit is collected separately to start with, and spread over the final surface in a 6 in. to 8 in. layer as a last prelude to replacing the turf.

Where the soil is homogeneous to some depth, it is obviously unnecessary to collect the top spit and replace it as a separate measure. In any case, however, a finely raked compost immediately below the turf is of great assistance, as is the addition of an artificial manure, such as sulphate of ammonia, in inducing the roots to strike quickly.

Where the turf is unsuitable for relaying, it should be removed by ploughing off, and burned in " bee-hive " like heaps, to be used as a top dressing on the seed bed to be formed.

Burnt soil is invaluable in this connection, and has the further advantage that any weed seeds, which might otherwise have been in the soil, have been destroyed by the operation of burning.

PREPARATION OF FOUNDATION.

Good drainage is an essential for all playing areas, the amount varying with the texture of the soil ; considerations of cost, however, will usually only permit of its use sparingly.

The normal method of drainage is by mean of agricultural drains, *viz.*, butt-joined porous earthenware pipes of varying diameters, and two feet in length.

The method of laying is to excavate main trenches at intervals along or across the area to be drained, with subsidiary branches or feeders in a herring-bone formation.

The actual distances apart are governed by the character of the soil, and the amount of water in it; but the average would be roughly :—

Main drains	100 ft. apart, 4 inches to 6" diam.
Feeders	15–25 ft. apart, 3" diam.
Fall, 1/40, Average depth ..	1 ft. to 2 ft. 6 in.

The distance apart of the feeders would vary according to the heaviness and water-holding capacity of the soil—a water-holding clay requiring feeders as close as 12–15 feet.

It is seldom advisable to reduce the size of the feeders below 3 in., as they tend to become blocked.

It is usually advisable to cover these drains with drawn wheat or rye straw, immediately surrounding the pipes, to prevent silting up, through fine ashes or sand percolating through the earthenware.

Failing straw, heather or bracken is serviceable, and will last several years. To enable storm water to run off quickly, the trenches should then be filled with clinker up to about 9 in. below the finished surface.

Shallow drains are best for stiff soils, but a greater depth is required for more porous soils—in gravelly soils two to three feet is suitable.

Even in such cases drainage definitely improves the turf, as not only does it sweeten, but it also raises the temperature of the soil.

On undrained soils the ground becomes hardened and parched up in dry weather.

On heavy soils a core of clean ashes is advisable, varying in thickness from 5 in. to 10 in.—although here, again, considerations of cost may make it prohibitive over any considerable area.

This core should be unrolled and laid in 3–4 in. layers, and raked to an even surface. Well-rotted stable manure can be intermixed with this core, with the object of tempting down the roots of the grass, and thus giving it a better opportunity of withstanding hard wear and drought.

It must be borne in mind, however, that grass is a surface-rooting plant, and that the effect of this intermixture of manure will be to encourage the growth of the coarser types, suitable for football fields, but not for tennis courts.

In cases where the turf is non-existent or unsuitable, there are only two alternatives to consider :—

(1) Turfing with turves obtained from a suitable locality.
(2) Seeding.

Turfing.

Turves are comparatively expensive to buy, and very bulky to transport, and unless suitable turf is obtainable in the near vicinity, it may be taken as an axiom that seeding will always be resorted to.

The provision of more expensive kinds of turf, such as Estuary, Mountain, and Downland, will never be justifiable for playing fields for troops; and turf available in the locality must be used. In fact, to ensure success, any turf from outside sources should be obtained from soil of the same nature as that to which it is to be transferred.

Each type of grass grows best under its own particular conditions of soil, etc., and transference to another set of conditions—even if apparently more favourable—merely results in the eventual disappearance of that particular type, and its substitution by the indigenous grasses of the locality. On the other hand, coarse grasses can be refined down to quite good turf by the addition, within reason, of dressings of sand or of charcoal.

Surface dressings of soil in many cases do more harm than good, as the object to be attained is healthy surface root growth, whereas the addition of soil on the surface merely makes it more difficult to obtain this result.

Seeding.

The necessary seed should be bought from a reputable firm, any of whom stock suitable seed for various soils and purposes.

When seeding has to be resorted to, the top surface requires special treatment, to prepare it for the reception of the seed.

An even surface, even in physical texture and fertilizing value of soil, is the first essential.

With large areas, such as football fields, this top surface can be intermixed with well-rotted stable manure, in the proportion of 20–30 tons per acre. The ground should then be tilled and cross-tilled with a rotary cultivator, and worked out to a friable condition.

Sowing, to be effective, must be done evenly, and this is difficult when done by hand, even on a still day. It is best done, therefore, by mixing the seed beforehand with dry earth and sand, and scattering the augmented bulk in handfuls.

The sown seed should then be covered with a layer of sifted soil or sand, and then well rolled with a light roller.

The application of a suitable chemical manure prior to seeding is also very beneficial.

The normal amount of seed for playing fields is 5–10 bushels per acre, five being normally sufficient for larger areas such as football grounds.

There are only two periods for seeding—the autumn or the spring, and there are arguments for and against each.

Autumn-sowing cannot be too early, in case of summer droughts, or too late in case of early frosts.

The time indicated, therefore, is late September or early October. Spring-sowing cannot be early, in case of late frosts, and must not be too late, in case of early drought, and should be, therefore, in March.

If autumn-sown, however, with reasonable weather, the pitch should be fit for play by the following spring year, whereas if spring-sowing is resorted to, the pitch is seldom fit for play until after the second winter.

Growth is seldom so luxuriant in the autumn as in the spring, but the ground being warmer than the air induces stronger root action, which enables the grasses to weather the winter with comparative safety, and to start away vigorously in the spring. Such grasses are less likely to succumb to drying winds, which often have a disastrous effect on the tender spring-sown ones.

In either case, certain precautions are necessary to ensure that a suitable grass surface is obtained.

These comprise, briefly :—

(1) The provision of scare-crows or some other device to frighten away birds.
(2) The constant removal by hand of loose stones working up to the surface.
(3) Scything when the young grass is two to three inches high. This induces greater root growth, and the thickening of the grass population.
(4) The next two or three cuts should also be done with the scythe, and the use of the mowing machine, with its harmful effects of wheel dragging on the sward, avoided, until the surface becomes firmly consolidated.
(5) Rolling at the correct time, *i.e.*, when the ground is drying, but not too dry. This can be done once or twice during the winter, particularly after hard frosts, when the grass plants tend to be become lifted from the ground, but not so as to cause surface caking, which may undo in one operation the work of a season.

There is no doubt that, on the whole, seeding is greatly to be preferred over turfing, for the following reasons :—

1. It is cheaper.
2. It is more reliable, and gives a cleaner surface eventually.
3. Special grasses can be selected to suit special conditions of soil, situation and climate.

It has the disadvantage of being much slower in giving the desired result of a sward fit for playing on, although this can be partly remedied by sowing more thickly and therefore at a greater cost in the beginning.

Cutting, when the turf is fully established, should never be stopped.

Checking growth above the surface induces new growth under the soil, with the consequent production of a close turf.

Judicious raking helps in this, by aerating the latent buds below ground, and inducing them to fresh growth.

The prick roller also helps greatly in aerating the surface.

The raking of large areas is too laborious, and in these cases a brush-harrow should be employed. This is also beneficial in breaking up and scattering worm-casts, which might otherwise be rolled flat, and seal up the air ducts in the soil.

Fertilizers.

This incessant propagation of new growth causes a drain on the resources of the soil; hence the need for fertilizers.

The prime need is for nitrogen—much of which is provided in an ordinary field by the clovers.

As these are undesirable features for other reasons, it has to be supplied by other means, of which the principal are sulphate of ammonia or nitrate of soda; of the two, sulphate of ammonia is probably the better.

A suitable method of applying sulphate of ammonia is as follows:—

Mark out the area to be treated in plots of 100 sq. ft.

Find a small jam jar, to hold 5 oz. of sulphate. Put this into a 3-gallon can, with a rose to it, and stir well.

Distribute this on the 100 sq. feet, and immediately follow with a can of clear water.

The first application should be in April, and repeated every fortnight or so till October. The sulphate of ammonia will destroy all clover, pearl-wort, chickweed, daisies, plantains and coarse grass, but it takes at least a season's steady application to effect this result. If too much is put on at a time, scorching of the grass is almost certain to result.

Other methods of fertilizing and removing various weeds can be briefly summarized as follows:—

1. For annual top dressings:

½ cwt. finely sifted soil 1 lb. sulphate of ammonia 2 lb. steamed bone flour 1 lb. canary guano	per 30 sq. yd.

Alternatively, dried and well-rotted poultry manure, mixed fifty-fifty with dry soil at the rate of ¼ cwt. per 30 sq. yd.

Or, weathered soot broadcast at the rate of 1 lb. per 30 sq. yd., or 1½ cwt. per acre.

Or, incinerated sewage sludge at the rate of 6–8 tons per acre.

2. Indirect manures—

Charcoal	..	..	2 tons per acre.
Sea sand	..	..	Ditto.
Salt ..	..	..	80 lb. per acre.

One or other of these can be used as an occasional top dressing to assist in the fining down of the grasses.

Lime is both a direct and indirect manure. The caustic forms are too drastic for lawns, and powdered chalk or limestone are preferable.

3. Weed eradication—

Moss—If due to poverty of soil, manure.
If due to acidity of soil, ground chalk.

Sorrel and docks—root out and apply ground chalk.

Plantains, thistles and dandelions—root out while ground is soft, or cut off and put thimbleful of sulphate of ammonia on each cut surface, or thrust into heart of each weed a wooden skewer dipped in hydrochloric acid.

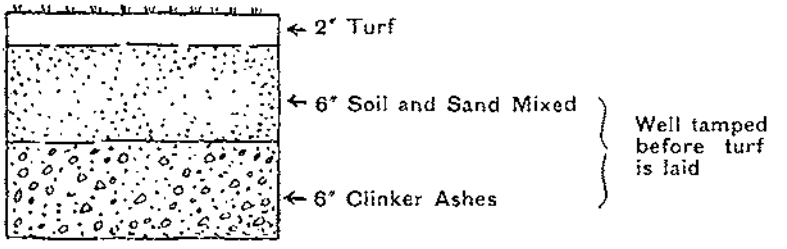
Daisies—Treat with lawn sand, *i.e.*, a mixture of 2 lb. sulphate of ammonia to ½ cwt. of finely-sifted soil; or lift and replace by clean turf.

(2). TENNIS COURTS AND CRICKET PITCHES.

More careful preparation, and a better surface texture, are required for these than for playing areas devoted to football, etc.

TENNIS COURTS.

The typical formation of a grass tennis-court is shown on the sketch below.



The object of the clinker is to provide an easily drained subsoil. It may also serve in preventing excessive downward growth of roots to limit the gross feeding of grasses where a rich and deep soil exists.

The intermediate layer ensures freedom from surface water logging, with its harmful effects on growth, and thus allowing for early play after rain; while at the same time providing nutriment for the grass.

SITING AND ORIENTATION.

Courts should be sited well away from trees, and particularly so that shadows do not fall on the court in the late afternoon.

Apart from the inconvenience caused to the players, their shade causes patchy drying of the surface, and consequent variability in conditions of growth. The position and height above the horizon of the sun during playing hours must also be borne in mind.

The main axis of the court should lie, therefore, roughly in the N–S line, with perhaps a slight tendency to the East. Apart from the actual area occupied by the court, it is essential to provide sufficient space on either side and at each end, and the following will be found to be satisfactory allowances in this respect :—

At each end, 21 feet. At sides, 12 feet. Between adjacent courts, 8 feet.

In no case should a reduction of more than 25% be made in any of these.

CRICKET PITCHES.

These require a more durable and lasting surface than for any other purpose, the wear and tear being excessive.

It is essential, therefore, to prepare specially an area large enough to enable pitches to be moved frequently, and one 40 yards by 40 yards is normally considered sufficient for this purpose.

The requirements are a hard, true surface, covered with fine grass mown so closely that it scarcely seems to rise above the surface. Peaty or sandy soils require the addition of a more adhesive soil, such as marly clay, but to get the best results it requires to be mixed in with the native soil, and not laid on the surface.

A cricket pitch should be so constructed that rain water is carried away rapidly to enable play to be resumed quickly, and the most suitable form of construction is therefore as follows :—

Remove the surface soil from the pitch area to a depth of about 15 in. and level the sub-soil evenly and solidly.

On the top of this lay 3 in. agricultural drains in a circle round the area, with a 3 in. fall to the outlet, and cover them with rubble.

Avoid laying pipes through the centre, as this tends to form a depression.

Lay a 6 in. to 8 in. layer of broken chalk as a sub-base, then mix, if necessary, the surface soil with marly clay, and lay the mixture or the original soil in thin layers on the chalk, treading down each until brought up to the required level.

Then lay turf or sow selected seed. Sprinkle the surface with chemical manure, and roll a few times in moderately dry weather with a light roller.

Mow close on all favourable dry occasions until a month before play commences. Then bring into use the heavy roller, and continue to mow frequently and roll sufficiently to get a good pitch.

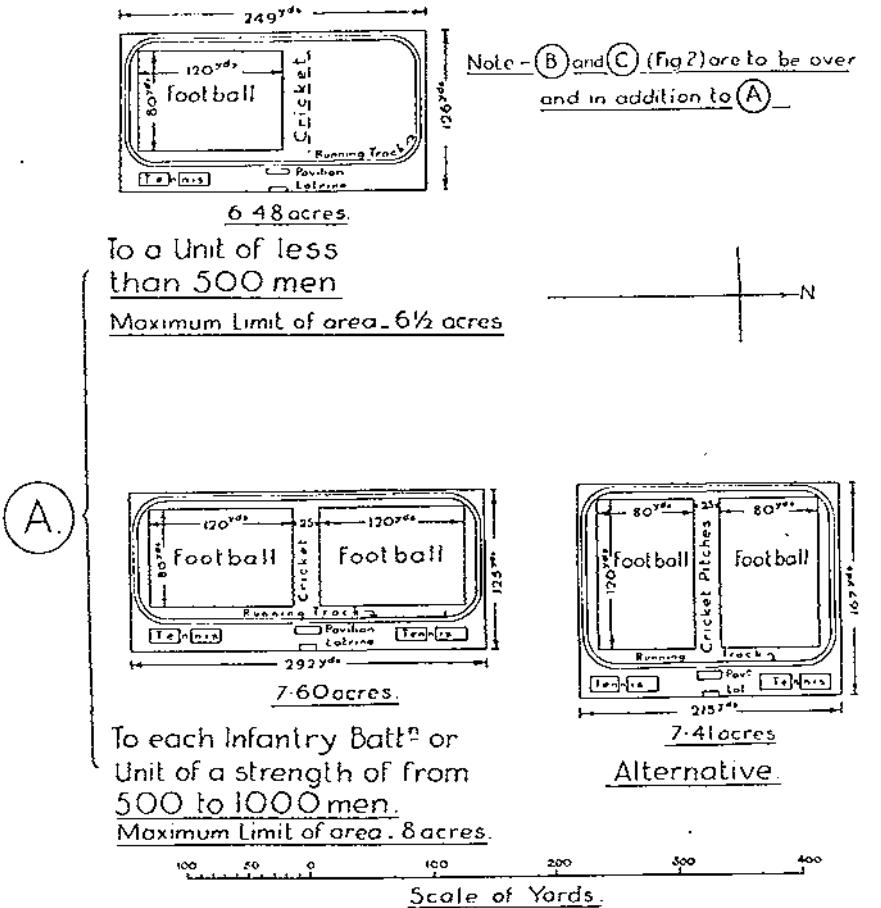
(3). Running Tracks.

These are authorized for all units, and for garrison grounds. In the former case grass tracks only are provided, and all that is required is to ensure that the playing area has a sufficiently wide grass verge to allow for a track round it.

In the latter case a cinder track is authorized.

The most suitable length for this is 440 yards, enabling the mile to be done in four laps, and it will be found that this length will enclose suitably a playing area comprising an Association football field, with a sufficient grass verge round the sides.

Fig. 1.



In any case it is essential that there should be stretches of straight of at least 100 yards in length, and that the bends should not be less than 30 yards radius.

It is of great advantage if a spur can be provided at one end to enable the 220 yards events to be run with only one easy bend to negotiate.

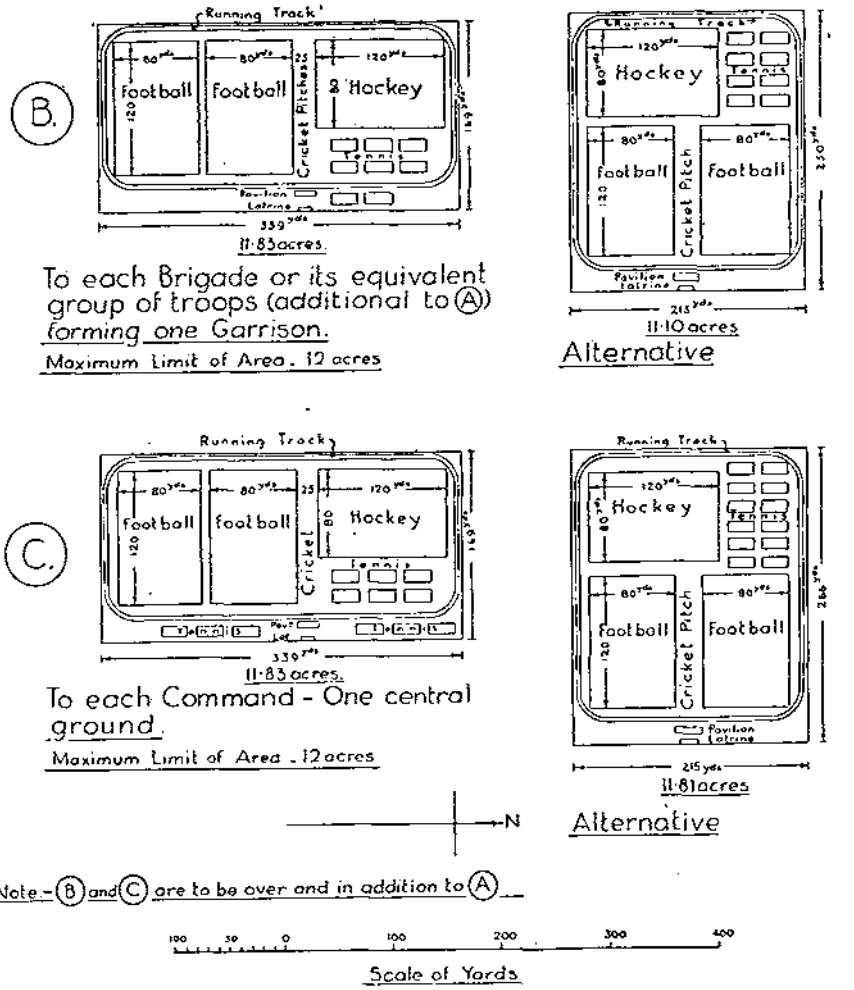
The width should be sufficient to enable four runners to compete

in the sprint events, running in strings, and should, therefore, be not less than 16 feet.

CONSTRUCTION.

The track is composed normally of 6 in. of well-sifted cinders on a 6 in. layer of clinker, broken brick or other suitable material. The formation level should be level, and rolled hard, and agricultural drains laid on its surface.

Fig. 2.



The 6 in. hard core layer should be laid on the top, and well compacted, and the cinders laid in 2 in. layers, each layer being well watered, rolled, and consolidated before the next one is laid.

Cinders for the top layer should pass through a 1/8th-inch mesh.

Subsequent maintenance consists of raking, watering, and rolling the surface, and removing any weeds, etc., which may spring up.

Lay-outs of recreation grounds, to suit various conditions, are shown in Figs. 1 and 2.

OFF-LOADING PONTOON EQUIPMENT AND FORMING RAFTS FROM A SHIP.

By LIEUT. L. T. GROVE, R.E.

IT may often happen that pontoon equipment has to be transported by sea and off-loaded into the water at the destination, and taken ashore on rafts, and a case occurred this year when it was decided to form a pontooning camp near Weymouth. Several lessons were learnt as a result of this experience, and a brief report may therefore be of interest. The equipment consisted of 28 Mk. IV pontoons, with proportionate superstructure, weighing in all just over 64 tons. It was loaded in a small 300-ton coasting steamer, called *Sir Redvers Buller*. The full cargo capacity of these boats is about 70 tons, all carried in a single hold forward. A swinging derrick is available for off-loading. There is only room for 26 pontoons in one of these holds, so that this type of boat can only carry up to 14 bays of medium bridge, apart from trestles. In this case the two extra pontoons had to be brought along in a barge.

The first problem is to get the stores loaded at the base in the most convenient way. Whenever possible, loading should be supervised by an R.E. officer, or someone who understands the use of pontoon equipment. The easiest way undoubtedly is to lay all the road-bearers on the floor of the hold, where they all fit in very nicely. Then the pontoons are stacked on top. Chesses are piled in heaps at the side of the hold, which is not quite filled with pontoons. The more awkward units, compound joists, trestle legs, transoms, etc., are laid round the deck ; they are not wanted for forming medium rafts, and simply get in the way. If this is not done, when the time comes to off-load, all the pontoons have to be taken out before the road-bearers can be raised to form rafts. This takes about two or three hours, and work is held up for that time, while the spare pontoons in the water are in the way, and may even be damaged if there is a swell running.

To simplify off-loading it is essential to have a proportion of road-bearers handy. These could be loaded between the separate layers of pontoons. There are actually four of these layers, and the best way is probably to have 20 road-bearers and 108 chesses between

the first and second layers, and again between the third and fourth. Packing would not be quite so easy, but it should be quite feasible, and it would save quite two hours in unloading to form raft. Trestle legs and transoms are best at the bottom of the hold, right out of the way. Compound joists do not pack well, and there is room for them at the stern of the ship, on deck. It is essential to have plenty of breastlines handy from the first, and it is also a good thing to have anchors and cables on deck for the first two rafts.

Off-loading should be carried out on both sides, so that two rafts can be formed at the same time. There is no difficulty in this, provided the material is not all taken from one side of the hold. If this is done the ship heels over, and the derrick cannot reach over to the far side. Pontoons can be lifted quite easily with four slings round the handrails. Road-bearers present the most trouble. They come up best in bundles of five. It simplifies matters if the centre of each has been marked when loading, as they have to be lifted by one sling round the middle. They are very liable to swing, and all men in the hold must be told to stand clear. No pontoons should be opposite a bundle of joists which is being lifted. Once in the air they are quite easily guided by hand to where they are wanted.

If these stores are merely being transported by rafts, it is better to make these up with only five road-bearers. If the rafts have to come straight into bridge it would, of course, be necessary to put in seven straight away. The other stores are quite easy to lift, but the rate of working is slow, and the officer in charge has to decide beforehand exactly what the next load is to consist of, and have everything ready.

The best way to form rafts is to have the piers alongside and boom out. The road-bearers are lowered at right angles to the piers, and the pins must be placed in the saddle of the inside pier. The outside pier then booms itself out. It must have a breastline at each end, held by men on the deck of the ship, especially if there is any current running. It is usually better to double-chess straight away, as this leaves more room for other stores on deck. A rough guide for loading is to stop when the handrail is awash. If this is exceeded, the raft becomes rather unmanageable in a stream, and is very heavy to row.

The detail of working parties requires consideration. The largest number that could be usefully employed on forming a raft was found to be 12. To save time, three parties of twelve were used, one on each raft, and the third resting out of the way. Each party provides a small detachment to work in the hold. This may be from 2 to 4 men, according to the state of off-loading. It was found better to let each party do its own jobs, rather than keep spare men for the purpose,

owing to the difficulty of supervising. These odd jobs keep cropping up, and a party gradually gets split up all over the ship. It is then better to call up the reserve party and take over completely, instead of trying to get the original party together again. This system was found to be more satisfactory than either time or task work, as the rate of off-loading with inexperienced men varies a great deal. As each party takes over, it can be given definite instructions to start on. Its subsequent procedure has to depend on circumstances.

When the rafts have been formed, it only remains to get them to the site. For this purpose the more men the better, up to the full complement of 22. So that, although only 36 men can be usefully employed on off-loading, owing to restrictions of space, many more are required in order to move off. A medium raft, loaded to the handrails, can be rowed against a current of two knots. Against anything stronger it is practically impossible to make any headway.

It is difficult to obtain an accurate estimate of the time such an operation should take. In the case described, 36 men did the work in about 20 working hours, including rowing the rafts for two miles against persistently unfavourable tides, but loading had not been supervised, and a lot of time was wasted on the first day before a successful organization of labour was arrived at. It then took about $1\frac{1}{4}$ hours to row the rafts up to the final site. Taking everything into consideration, it should be possible to get six medium rafts formed and loaded with superstructure in 8 to 10 working hours. This assumes no previous experience of such work, but favourable weather conditions, and properly supervised loading. The additional time required to get to the final site must depend entirely on the situation.

CLIFFORD'S FORT, NORTH SHIELDS.

On May 12th, 1928, the Tyne Electrical Engineers, R.E., whose official designation is the 307th (Tyne) A.A.S.L. Co., vacated their old headquarters in Clifford's Fort, North Shields, and moved to their new drill hall beside Tynemouth Railway Station. They had been in occupation of Clifford's Fort since 1887, when the unit was first formed, under the title of the Tyne Division, Submarine Miners, R.E. Volunteers.

The troops paraded at Clifford's Fort, and, after the " Last Post " had been sounded, they marched with their Regimental Band to the parade ground on the new site, where the " Reveille " was sounded. The ceremony included the striking of the flag at Clifford's Fort just before the parade was marched off, and the breaking of the flag at the new Headquarters, immediately following the entrance of the troops. Many former officers of the Corps were present at the ceremony.

Clifford's Fort was built in 1672, during the Dutch Wars, in Charles II.'s reign. It mounted 40 guns, but was never under fire. It withstood, however, a " siege," or rather, an assault, in 1804, an account of which is reprinted from *The Shields Daily News* :—

" Perhaps the most interesting anecdote about the old place is the story of the celebrated ' siege ' in 1804. On April 30th of that year, the North Shields and Tynemouth Volunteers entered upon duty for one month. The guards at Clifford's Fort, Tynemouth Barracks, and the Spanish Battery, were delivered up to them. At Clifford's Fort the company had not been in occupation for more than four hours when Major Doyle, of the Light Brigade, from Sunderland, crossed the Tyne in a vessel, accompanied by one company of the 61st Regiment, one company of the Northumberland Militia, and one company Lanark Militia. The officers, it appears, had got rather vainglorious over their cups, and when disputing over the merits of their respective corps, the major had said he could easily surprise any of the forts garrisoned by the Volunteers, and he was dared to make the attempt. Unfortunately for himself, he chose Clifford's Fort as his intended victim.

" He landed with his troops in the early morning, and from the Lighthouse Sands proceeded as noiselessly as possible, the major leading on his charger, up the narrow passage close to the Fort. But before they could reach the gates, the Volunteers had made prepara-

tions to receive them, their landing having been observed in spite of their caution.

"The number of Volunteers within the fort was insufficient for the guarding of the embrasures and the walls, however, so an 'express' was sent off for the remainder of the Corps, who happened to be on parade in Dockwray Square. These had already noticed what was going on, and they hastened down the bank to the assistance of their comrades. They forced the pass along the narrow passage mentioned above at the point of the bayonet.

"There was a sharp scuffle, and later the besiegers attempted to take the Fort by storm, but another attack in the rear saved the situation.

"Captain Robert Shield, of the Volunteers, was captured by the Northumberland Militia, but he was rescued.

"Meanwhile, the assailants of the Fort had been overpowered, and retreated sullenly to the flat-bottomed *Buonapart*, in which they had crossed the Tyne.

"But their cup of bitterness was not yet full, for on arriving at the Bents they found that a party of Volunteers, headed by Captain Shield, who was thirsting for revenge for being captured, had slipped across the river in scullerboats, and demolished the attackers' camp and carried off their flags. This was worse than defeat, as it involved disgrace, and it was many a long day before the incident was forgotten.

"The affair was a feather in the cap of the Volunteers, who proved themselves more than worthy of being entrusted with the Fort. The Fort was not built to resist a land attack, and it is interesting to note that one-third of the attacking party were soldiers of the line.

"Since 1860 the history of the Fort is somewhat uneventful. During that time, the march of progress brought about many changes in the place, and nearly all the old features became obsolete and disappeared."

The old fort, after this one eventful happening in its history, will now disappear, to make room for Fish Quay extensions.

The Editor is indebted to the Commanding Officer, Bt. Lieut.-Colonel N. H. Firmin, O.B.E., T.D., for the above information.

BATTLE HONOURS OF ROYAL ENGINEER UNITS

(Continued from December, 1927, R.E. Journal).

ITALY.

PIAVE. 15TH TO 24TH JUNE, 1918.

Unit.	Formation.		Remarks.
54th Field Co.	7th Div.	D.	
95th ,,	,,	,,	
528th (Durham) Field Co.	,,	E.	
101st Field Co.	23rd Div.	,,	
102nd ,,	,,	,,	
128th ,,	,,	,,	
474th (S.M.) Field Co.	48th (S.M.) Div.	,,	
475th ,,	,,	,,	
477th ,,	,,	,,	
ARMY TROOPS.			
158th Army Troops Co. (A and C Sections).		N.E.	No diary.
285th Army Troops Co.		,,	No diary.
8th Mon. Army Troops Co.		,,	
No. 4 Pontoon Park (M.T.)		D.	
No. 5 ,, (H.T.)		E.	
No. 6 Field Survey Co.		D.	No diary.
No. 34 A.A. Searchlight Sec.		,,	No diary.

SIGNALS.

PIAVE. 15TH TO 24TH JUNE, 1918.

Unit.	Formation.		Remarks.
G.H.Q. Signal Co.	G.H.Q.	E.	
7th Divl. Signal Co.	7th Div.	D.	
23rd ,,	23rd ,,	E.	
48th ,,	48th ,,	,,	

VITTORIO VENETO. 24TH OCTOBER TO 4TH NOVEMBER, 1918.

Unit.	Formation.		Remarks.
474th (S.M.) Field Co.	48th (S.M. Div.)	E.	
475th ,,	,,	,,	
477th ,,	,,	,,	With XIV Corps.
XIV CORPS.			
54th Field Co.	7th Div.	E.	
95th ,,	,,	,,	
528th ,,	,,	,,	
101st ,,	23rd Div.	,,	
102nd ,,	,,	,,	
128th ,,	,,	,,	
ARMY TROOPS.			
158th Army Troops Co. (A and C Sections).		N.E.	No diary.
285th Army Troops Co.		,,	No diary.
8th Mon. Army Troops Co.		,,	
No. 4 Pontoon Park (M.T.)		E.	
No. 5 ,, (H.T.)		,,	
No. 6 Field Survey Co.		D.	No diary.
No. 34 A.A. Searchlight Sec.		,,	No diary.

SIGNALS.

VITTORIO VENETO. 24TH OCTOBER TO 4TH NOVEMBER, 1918.

Unit.	Formation.		Remarks.
G.H.Q. Signal Co.		N.E.	
XIV Corps Signal Co.	XIV Corps	E.	
7th Divl. Signal Co.	7th Div.	,,	
23rd ,,	23rd ,,	,,	
48th ,,	48th ,,	,,	

MACEDONIA.

KOSTURINO. 7TH TO 8TH DECEMBER, 1915.

Unit.	Formation.		Remarks.
65th Field Co.	10th Div.	E.	
66th ,,	,,	,,	
85th ,,	,,	,,	No diary.

SIGNALS.

KOSTURINO. 7TH TO 8TH DECEMBER, 1915.

Unit.	Formation.		Remarks.
10th Divl. Signal Co.	10th Div.	E.	

STRUMA. 30TH SEPTEMBER TO 4TH OCTOBER, 1916.

Unit.	Formation.		Remarks.
XVI CORPS.			
65th Field Co.	10th Div.	E.	
66th ,,	,,	,,	
85th ,,	,,	,,	
17th ,,	27th Div.	N.E.	
1/1st Wessex Field Co.	,,	E.	
1/2nd ,,	,,	,,	
38th Field Co.	28th Div.	N.E.	
2/1st Northn. Field Co.	,,	E.	
1/7th Hants Field Co.	,,	,,	
143rd Army Troops Co.	XVI Corps	N.E.	
287th ,,	,,	,,	

SIGNALS.

STRUMA. 30TH SEPTEMBER TO 4TH OCTOBER, 1916.

Unit.	Formation.		Remarks.
XVI Corps Signal Co.	XVI Corps	D.	No diary.
10th Divl. Signal Co.	10th Div.	E.	
27th ,,	27th ,,	,,	
28th ,,	28th ,,	,,	

DOIRAN, 1917. 24TH TO 25TH APRIL AND 8TH TO 9TH MAY, 1917.

Unit.	Formation.		Remarks.
XII CORPS.			
99th Field Co.	22nd Div.	E.	
100th ,,	,,	,,	
127th ,,	,,	,,	
107th ,,	26th Div.	,,	
108th ,,	,,	,,	
131st ,,	,,	,,	
519th ,,	60th Div.	,,	
521st ,,	,,	,,	
522nd ,,	,,	,,	
9th Field Troop	XII Corps	N.E.	
137th Army Troops Co.	,,	,,	No diary.
140th ,,	,,	,,	
286th ,,	,,	,,	

SIGNALS.

DOIRAN, 1917. 24TH TO 25TH APRIL AND 8TH TO 9TH MAY, 1917.

Unit.	Formation.		Remarks.
M Corps Signal Co.	XII Corps	D.	
22nd Divl. Signal Co.	22nd Div.	E.	
26th ,,	26th ,,	,,	
60th ,,	60th ,,	,,	

DOIRAN, 1918. 18TH TO 19TH SEPTEMBER, 1918.

Unit.	Formation.		Remarks.
XII CORPS.			
99th Field Co.	22nd Div.	E.	
100th ,,	,,	,,	
127th ,,	,,	,,	
107th ,,	26th Div.	,,	
108th ,,	,,	,,	
131st ,,	,,	,,	
17th ,,	27th Div.	N.E.	
500th (Wessex) Field Co.	,,	,,	
501st ,,	,,	,,	
37th Army Troops Co.	L. of C.	,,	
137th ,,	,,	,,	
139th ,,	,,	,,	
140th ,,	XII Corps	E.	
143rd ,,	,,	,,	
286th ,,	,,	,,	
117th Railway Co.	L. of C.	N.E.	
267th Railway Con. Co.	,,	,,	

SIGNALS.

DOIRAN, 1918. 18TH TO 19TH SEPTEMBER, 1918.

Unit.	Formation.		Remarks.
M Corps Signal Co.	XII Corps	E.	
22nd Divl Signal Co.	22nd Div.	,,	
26th ,,	26th ,,	,,	
27th ,,	27th ,,	D.	

GALLIPOLI.

HELLES. 25TH APRIL TO 6TH JUNE, 1915.

Unit.	Formation.		Remarks.
All units E for "Landing at "Helles" and "Krithia," and, in addition, "Nil."		E. ,, ,,	

LANDING AT HELLES. 25TH AND 26TH APRIL, 1915.

Unit.	Formation.		Remarks.
2nd London Fd. Co.	29th Div.	E.	
1/2nd Lowland Fd. Co.	,,	,,	
1st W. Riding Fd. Co.	,,	,,	
1st London Div. Sig. Co.	,,	,,	No unit diary. Verified in diary of G.S. 29th Div.
No. 1 R.N. Div. Fd. Co.	R.N. Div.	N.E.	No unit diary. Verified in diary of B.G. R.E.
No. 2 ,,	,,	,,	,,
R.N. Div. Sig. Co.	,,	,,	,,
1/1st East Lancs. Fd. Co.	42nd Div.	,,	
1/2nd ,,	,,	,,	No unit diary. Verified in diary of B.G. R.E.
42nd (E.Lan.) Div. Sig. Co.	,,	,,	
2/1st Lowland Fd. Co.	52nd Div.	,,	
2/2nd ,,	,,	,,	
52nd Div. Sig. Co.	,,	,,	
1/2nd W. Lan. Fd. Co. (attd.)	,,	,,	
VIII Corps Sig. Co.	VIII Corps	,,	This unit disembarked on Peninsular 26.7.15. An A.T. Signal Co. is shown in a Transport return of 29th Div. relating to the Landing, but the unit cannot be identified.

KRITHIA. 4TH JUNE, 1915.

Unit.	Formation.		Remarks.
1/2nd Lowland Fd. Co.	29th Div.	E.	
2nd London Fd. Co.	,,	,,	
1st West Riding Fd. Co.	,,	,,	
29th Div. Sig. Co.	,,	,,	
No. 1 R.N. Div. Fd. Co.	R.N. Div.	,,	
No. 2 ,,	,,	,,	
R.N. Div. Sig. Co.	,,	,,	
1/1st East Lancs. Fd. Co.	42nd Div.	,,	
1/2nd ,,	,,	,,	
42nd E. Lan. Div. Sig. Co.	,,	,,	No unit diary. Presumptive evidence.
2/1st Lowland Fd. Co.	52nd Div.	N.E.	
2/2nd ,,	,,	,,	
1/2nd W. Lan. Fd. Co.	,,	,,	
52nd Div. Sig. Co.	,,	,,	
1/3rd Lanc. Works Co.	L. of C.	E.	No unit diary. A Lancashire Fusilier Co. is mentioned by B.G. R.E. was landing at Helles on 30.4.15; this is the only unit in Order of Battle which can be meant.

ANZAC. 25TH APRIL TO 30TH JUNE, 1915.

Unit.	Formation	Remarks.
All units E for Landing at "Anzac" and "Defence of Anzac" and in addition	R.E.	E. ,,
2nd New Zealand Fd. Co.	N.Z. and A Div.	,,

LANDING AT ANZAC. 25TH TO 26TH APRIL, 1915.

Unit.	Formation.	Remarks.
1st Aust. Fd. Co.	1st Aust.Div.	E.
2nd ,,	,,	,,
3rd ,,	,,	,,
1st Aust. Div. Sig. Co.	,,	,,
1st N.Z. Fd. Co.	N.Z. and A. Div.	,,
2nd ,,	,,	N.E.
1st N.Z. Field Troop	,,	,,
A. and N.Z. Div. Sig. Co.	,,	E.
Anzac Corps Sig. Co.	Anzac Corps	N.E.

DEFENCE OF ANZAC. 19TH TO 21ST MAY, 1915.

Unit.	Formation.	Remarks.
1st Aust. Fd. Co.	1st Aust. Div.	E.
2nd ,,	,,	,,
3rd ,,	,,	,,
1st Aust. Div. Sig. Co.	,,	,,
1st N.Z. Fd. Co.	N.Z. and A. Div.	,,
2nd ,,	,,	N.E.
1st N.Z. Fd. Troop	,,	E.
A. & N.Z. Div. Sig. Co.	,,	,,
Anzac Corps Sig. Co.	Anzac Corps	,,

SUVLA. 6TH TO 21ST AUGUST, 1915.

Unit.	Formation.	Remarks.
All units E for "Sari Bair" "Landing at Suvla," "Scimitar Hill," and in addition "Nil."		E. ,, ,,

SARI BAIR. 6TH TO 10TH AUGUST, 1915.

Unit.	Formation.	Remarks.
65th Field Co.	10th Div.	N.E.
66th ,,	,,	,,
88th ,,	,,	,,
10th Div. Sig. Co.	,,	,,
67th Field Co.	11th Div.	,,
68th ,,	,,	,,
86th ,,	,,	,,
11th Div. Sig. Co.	,,	,,

SARI BAIR. 6TH TO 10TH AUGUST, 1915.

Unit.	Formation.		Remarks.
71st Field Co.	13th Div.	E.	
72nd ,,	,,	,,	
88th ,,	,,	,,	
15th Div. Sig. Co.	,,	,,	
1/2nd London Field Co.	29th Div.	N.E.	
1/2nd Lowland Field Co.	,,	,,	
1/1st W. Riding Field Co.	,,	,,	
29th Div. Sig. Co.	,,	,,	
R.E. Div. units of 42nd Div.	42nd Div.	,,	
R.E. Div. units of 52nd Div.	52nd Div.	,,	
R.E. Div. units of 53rd Div.	53rd Div.	,,	
R.E. Div. units of 54th Div.	54th Div.	,,	
R.E. Div. units of R.N. Div.	R.N. Div.	,,	
1st Aust. Field Co.	1st Aust. Div.	E.	
2nd ,,	,,	,,	
3rd ,,	,,	,,	
1st Aust. Div. Sig. Co.	,,	,,	
1st N.Z. Field Co.	N.Z. and A. Div.	E.	
2nd ,,	,,	,,	
1st N.Z. Field Troop	,,	,,	
A. and N.Z. Div. Sig. Co.	,,	,,	
R.E. units of 2nd Aust. Div.	2nd Aust. Div.	N.E.	
Anzac Corps Sig. Co.	Anzac Corps	E.	

LANDING AT SUVLA. 6TH TO 15TH AUGUST, 1915.

Unit.	Formation.		Remarks.
65th Field Co.	10th Div.	E.	
66th ,,	,,	,,	
85th ,,	,,	,,	No unit diary. Presumptive evidence.
67th ,,	11th Div.	,,	
68th ,,	,,	,,	
86th ,,	,,	,,	
11th Div. Sig. Co.	,,	,,	No unit diary. Presumptive evidence.
71st Field Co.	13th Div.	N.E.	
72nd ,,	,,	,,	
88th ,,	,,	,,	
13th Div. Sig. Co.	,,	,,	
1/2nd London Field Co.	29th Div.	,,	
1/2nd Lowland Field Co.	,,	,,	
1/1st W. Riding Fd. Co.	,,	,,	
29th Div. Sig. Co.	,,	,,	
R.E. Div. units of 42nd Div.	42nd Div.	,,	
R.E. Div. units of 52nd Div.	52nd Div.	,,	
1/1st Welsh Field Co.	53rd Div.	E.	
2/1st ,,	,,	,,	No unit diary. Presumptive evidence.
2/1st Cheshire Field Co.	,,	,,	
53rd Div. Sig. Co.	,,	,,	
1/2nd E. Anglian Field Co.	54th Div.	N.E.	
2/1st ,,	,,	,,	
54th Div. Sig. Co.	,,	,,	
1st Aust. Field Co.	1st Aust. Div.	N.E.	
2nd ,,	,,	,,	
3rd ,,	,,	,,	
1st Aust. Div. Sig. Co.	,,	,,	
1st N.Z. Field Co.	N.Z. and A. Div.	,,	
2nd ,,	,,	,,	
1st N.Z. Field Troop	,,	,,	
A. & N.Z. Div. Sig. Co.	,,	,,	

LANDING AT SUVLA. 6TH TO 15TH AUGUST, 1915.

Unit.	Formation.		Remarks.
R.E. Div. units of 2nd Aust. Div.	2nd Aust. Div.	N.E.	
R.E. Div. units of R.N. Div.	R.N. Div.	,,	
IX Corps Signal Co.	IX Corps	E.	No unit diary. Presumptive evidence.
133rd Fortress Co.	L. of C.	,,	
Australian Bridging Train	,,	,,	

SCIMITAR HILL, 21ST AUGUST, 1915.

Unit.	Formation.		Remarks.
65th Field Co.	10th Div.	E	
66th ,,	,,	,,	
85th ,,	,,	,,	
10th Div. Sig. Co.	,,	,,	No unit diary. Presumptive evidence.
67th ,,	11th Div.	,,	
68th ,,	,,	,,	
86th ,,	,,	,,	
11th Div. Sig. Co.	,,	,,	No unit diary. Presumptive evidence.
71st Field Co.	13th Div.	N.E.	
72nd ,,	,,	,,	
88th ,,	,,	,,	
13th Div. Sig. Co.	,,	,,	
1/2nd London Field Co.	29th Div.	E.	
1/2nd Lowland Field Co.	,,	,,	
1/1st W. Riding Field Co.	,,	,,	
29th Div. Sig. Co.	,,	,,	No unit diary. Presumptive evidence.
R.E. Div. units of 42nd Div.	42nd Div.	N.E.	
R.E. Div. units of 52nd Div.	52nd Div.	,,	
1/1st Welsh Field Co.	53rd Div.	E.	
2/1st ,,	,,	,,	No unit diary. Presumptive evidence.
2/1st Cheshire Field Co.	,,	,,	
53rd Div. Sig. Co.	,,	,,	
1/2nd E. Anglian Field Co.	54th Div	,,	
2/1st ,,	,,	,,	No unit diary. Presumptive evidence.
54th E. Anglian Div. Sig. Co.	,,	,,	
1st Aust. Field Co.	1st Aust. Div.	N.E.	
2nd ,,	,,	,,	
3rd ,,	,,	,,	
1st Aust. Div. Sig. Co.	,,	,,	
1st N.Z. Field Co.	N.Z. and A. Div.	,,	
2nd ,,	,,	,,	
1st N.Z. Field Troop	,,	,,	
A. & N.Z. Div. Sig. Co.	,,	,,	
R.E. units of 2nd Aust. Div.	2nd Aust. Div.	,,	
R.E. units of R.N. Div.	R.N. Div.	,,	
IX Corps Sig. Co.	IX Corps	E.	No unit diary. Presumptive evidence.
133rd Fortress Co.	L. of C.	,,	
Australian Bridging Train	,,	,,	

GALLIPOLI. 25TH APRIL, 1915, TO 8TH JANUARY, 1916.

Unit.	Formation.		Remarks.
All units E for			
"Helles"		E.	
"Landing at Helles"		,,	
"Krithia"		,,	
"Anzac"		,,	
"Landing at Anzac"		,,	
"Defence of Anzac"		,,	
"Suvla"		,,	
"Landing at Suvla"		,,	
"Scimitar Hill"		,,	
"Sari Bair"		,,	
and in addition,			
3rd R.N. Div. Field Co.	R.N. Div.	,,	
1/1st Kent Field Co.	L. of C. (Mounted Div.)	,,	
1/2nd ,,	,,	,,	
4th Aust. Field Co.	2nd Aust. Div.	,,	
5th ,, (later numbered 8th Aust. Field Co.)	,,	,,	
2nd Aust. Div. Sig. Co.	,,	,,	
37th Fortress Co.	L. of C.	,,	
No. 5 Siege Co. R. Monmouth R.E.	,,	,,	
136th Fortress Co.	,,	,,	
134th ,,	,,	,,	
VIII Corps Sig. Co.	VIII Corps	,,	
M. (L. of C.) Sig. Co.	G.H.Q.	,,	Detachments on the Peninsular.
14th Fortress Co.	L. of C.	D.	
1/3rd Devon Fortress Co.	,,	,,	
Anglesey Siege Co.	,,	,,	
117th Railway Co.	,,	,,	
13th Base Park Co.	,,	,,	
46th ,,	,,	,,	
Mounted Div. Sig. Sqdrn.	Mounted Div.	,,	
			The diaries of units and also of higher formations are missing in a great many cases. It has been extremely difficult to compile lists of eligibility and the completeness and accuracy of the lists is doubtful.

EGYPT.

SUEZ CANAL. 3RD TO 4TH FEBRUARY, 1915.

Unit.	Formation.		Remarks.
1st E. Lancs. Field Co.	42nd (E. Lancs.) Div.	E.	Attached 22nd Indian Inf. Bde.
No. 10 Co. Q.VO. S. & M..	11th Indian Div.	E.	

RUMANI. 4TH TO 5TH AUGUST, 1916.

Unit.	Formation.		Remarks.
1/1st E. Lancs. Field Co.	42nd (E. Lanc.) Div.	E.	
1/2nd ,,	,,	,,	
1/3rd ,,	,,	,,	
2/1st Lowland Field Co.	52nd (Lowland) Div.	,,	
1/2nd ,,	,,	,,	
2/2nd ,,	,,	,,	
1/1st Welsh Field Co.	53rd Div.	N.E.	
2/1st ,,	,,	,,	
2/1st Cheshire Field Co.	,,	,,	
2/1st E. Ang. Field Co.	54th Div.	,,	
1/2nd ,,	,,	,,	
1/1st Kent Field Co.	,,	,,	
No. 7 Field Troop	Canal Defences	E.	
No. 9 ,,	,,	N.E.	
1st Aust. Field Sqdrn.	,,	D.	
14th Army Troops Co.	,,	N.E.	
220th ,,	,,	D.	
No. 5 Siege Co. R.M. R.E.	,,	,,	

SIGNALS.

RUMANI. 4TH TO 5TH AUGUST, 1916.

Unit.	Formation.		Remarks.
42nd Div. Signal Co.	42nd Div.	E.	
52nd ,,	52nd ,,	,,	
53rd ,,	53rd ,,	N.E.	
54th ,,	54th ,,	,,	

RAFAH. 9TH JANUARY, 1917.

Unit.	Formation.		Remarks.
1st Aust. Field Sqdrn.	A. & N.Z. Mtd. Div.	E.	
No. 7 Field Troop	5th Mtd. Bde.	D.	No diary.
No. 10 Co. Q.V.O.S. & M.	Desert Column.	N.E.	
2/1st Cheshire Field Co.	53rd Div.	E.	Attached A. & N.Z. Mtd. Div.
1/1st E. Lancs. Field Co.	42nd Div.	N.E.	
1/2nd ,,	,,	,,	
1/3rd ,,	,,	,,	
2/1st Lowland Field Co.	52nd Div.	,,	
1/2nd ,,	,,	,,	
2/2nd ,,	,,	,,	

SIGNALS.

RAFAH. 9TH JANUARY, 1917.

Unit.	Formation.		Remarks.
W Corps Signal Co.	Desert Column	N.E.	
1st A. & N.Z. Sig. Sqdrn.	Anzac Mtd. Div.	E.	
5th Mtd. Bde. Sig. Troop	Desert Column	D.	
42nd Div. Sig. Co.	,,	N.E.	No diary.
52nd ,,	,,	,,	No diary.

PALESTINE.

GAZA. 26TH TO 27TH MARCH, 1917. 17TH TO 19TH APRIL, 1917. 27TH OCTOBER TO 7TH NOVEMBER, 1917.

Unit.	Formation.		Remarks.
XX CORPS.			
65th Field Co.	10th Div.	E.	
66th ,,	,,	,,	
85th ,,	,,	,,	
436th (Welch) Field Co.	53rd Div.	,,	
437th ,,	,,	,,	
439th (Cheshire) Field Co.	,,	,,	
519th (London) Field Co.	60th Div.	,,	
521st ,,	,,	,,	
522nd ,,	,,	,,	
No. 5 Field Co. R.M.R.E.	74th Div.	,,	
No. 5 Field Co. R.A.R.E.	,,	,,	
XXI CORPS.			
410th (Lowland) Field Co.	52nd Div.	,,	
412th ,,	,,	,,	
413th ,,	,,	,,	
484th (E. Ang.) Field Co.	54th Div.	,,	
486th ,,	,,	,,	
495th (Kent) Field Co.	75th Div.	,,	
496th ,,	,,	,,	
DESERT MOUNTED CORPS.			
No. 8 Field Troop	7th Mtd. Bde.	,,	No diary.
No. 10 ,,	Imp. Camel Corps Bde.	,,	
No. 4 Aust. Field Troop	Desert Mtd. Cps.	,,	No diary.
1st Aust. Field Sqdrn.	Anzac Mtd. Div.	,,	
2nd ,,	Aust. Mtd. Div.	,,	
No. 6 Field Sqdrn.	Yeomanry Mtd. Div.	,,	
ARMY TROOPS.			
14th Army Troops Co.	XXI Corps	E.	
35th ,,	G.H.Q.	N.E.	
220th ,,	XX Corps	E.	
No. 10 Fd. Co. 2nd Q.V.O.	L. of C.D.	E.	
115th Railway Co.	G.H.Q.	,,	
116th ,,	,,	,,	
265th ,,	,,	,,	
266th ,,	,,	,,	
359th Co. R.E. (Water Unit)	L. of C.	N.E.	
360th ,,	,,	,,	
555th (Lancs.) Army Troops Co.	,,	D.	No diary.
569th (Devon) ,,	,,	N.E.	
570th (Devon) ,,	,,	,,	
571st Army Troops Co.	,,	,,	

SIGNALS.

GAZA. 26TH TO 27TH MARCH, 1917. 17TH TO 19TH APRIL, 1917. 27TH OCTOBER TO 7TH NOVEMBER, 1917.

Unit.	Formation.		Remarks.
V Corps Signal Co.	XX Corps	E.	
10th Div. Signal Co.	10th Div.	,,	
53rd ,,	53rd ,,	,,	
60th ,,	60th ,,	,,	
74th ,,	74th ,,	,,	
U Corps Signal Co.	XXI Corps	D.	

SIGNALS.

GAZA. 26TH TO 27TH MARCH, 1917. 17TH TO 19TH APRIL, 1917. 27TH OCTOBER TO 7TH NOVEMBER, 1917.

Unit.	Formation.		Remarks.
52nd Div. Signal Co.	52nd Div.	E.	
54th ,,	54th ,,	,,	
75th ,,	75th ,,	,,	
W Corps Signal Co.	Desert Mtd. Corps	,,	No diary.
Bde. Signal Section	7th Mtd. Bde.	,,	No diary.
,,	Imp. Camel Corps Bde.	,,	
1st Aust. Signal Sqdrn.	Anzac Mtd. Div.	,,	
2nd ,,	Aust. Mtd. Div.	,,	
Yeomanry Mtd. Div. Sig. Sqdrn.	Yeomanry Mtd. Div.	,,	

EL MUGHAR. 13TH NOVEMBER, 1917.

Unit.	Formation.		Remarks.
XX CORPS.			
436th (Welsh) Field Co.	53rd Div.	E.	
437th ,,	,,	,,	
439th (Cheshire) Field Co.	,,	,,	
519th (London) Field Co.	60th Div.	,,	
521st ,,	,,	,,	
522nd ,,	,,	,,	
XXI CORPS.			
410th (Lowland) Field Co.	52nd Div.	,,	
412th ,,	,,	,,	
413th ,,	,,	,,	
484th (E. Ang.) Field Co.	54th Div.	,,	
486th ,,	,,	,,	
495th (Kent) Field Co.	75th Div.	,,	
496th ,,	,,	,,	
DESERT MOUNTED CORPS.			
4th Aust. Field Troop	C.H.Q.	,,	
No. 8 Field Troop	7th Mtd. Bde.	,,	
No. 10 ,,	Imp. Camel Corps Bde.	,,	
1st Aust. Field Sqdrn.	Anzac Mtd. Div.	,,	
2nd Aust. ,,	Aust. Mtd. Div.	,,	
No. 6 Field Sqdrn.	Yeomanry Mtd. Div.	,,	
ARMY TROOPS.			
14th Army Troops Co.	XXI Corps	E.	
35th ,,	G.H.Q.	N.E.	
220th ,,	XX Corps	,,	
No. 10 Co. 2nd S. and M.	L. of C.D.	,,	

SIGNALS.

EL MUGHAR. 13TH NOVEMBER, 1917.

Unit.	Formation.		Remarks.
V Corps Signal Co.	XX Corps	D.	
53rd Div. Signal Co.	53rd Div.	E.	
60th ,,	60th Div.	,,	
U Corps Signal Co.	XXI Corps	,,	

SIGNALS.

EL MUGHAR. 13TH NOVEMBER, 1917.

Unit.	Formation.		Remarks.
52nd Div. Signal Co.	52nd Div.	E.	
54th ,,	54th Div.	,,	
75th ,,	75th Div.	,,	
W Corps Signal Co.	Desert Mtd. Cps.	,,	No diary.
Bde Signal Sec.	7th Mtd. Bde.	,,	No diary.
,,	Imp. Camel Corps Bde.	,,	No diary.
1st Aust. Signal Sqdrn.	Anzac Mtd. Div.	,,	
2nd ,,	Aust. Mtd. Div.	,,	
Yeomanry Mtd. Div. Sig. Sqdrn.	Yeomanry Mtd. Div.	,,	

NEBI SAMWIL. 17TH TO 24TH NOVEMBER, 1917.

Unit.	Formation.		Remarks.
XXI CORPS.			
410th (Lowland) Field Co.	52nd Div.	E.	
412th ,,	,,	,,	
413th ,,	,,	,,	
484th (E. Ang.) Field Co.	54th Div.	,,	
486th ,,	,,	,,	
495th (Kent) Field Co.	75th Div.	,,	
496th ,,	,,	,,	
519th (London) Field Co.	60th Div.	,,	
521st ,,	,,	,,	
522nd ,,	,,	,,	
DESERT MTD. CORPS.			
4th Aust. Field Troop	C.H.Q.	,,	
No. 8 Field Troop	7th Mtd. Bde.	,,	
No. 10 ,,	Imp. Camel Corps Bde.	,,	
1st Aust. Field Sqdrn.	Anzac Mtd. Div.	,,	
2nd ,,	Aust. Mtd. Div.	,,	
No. 6 Field Sqdrn.	Yeomanry Mtd. Div.	,,	
ARMY TROOPS.			
14th Army Troops Co.	XXI Corps	,,	
220th ,,	XX Corps	N.E.	

SIGNALS.

NEBI SAMWIL. 17TH TO 24TH NOVEMBER, 1917.

Unit.	Formation.		Remarks.
U Corps Signal Co.	XXI Corps	E.	
52nd Div. Signal Co.	,,	,,	
54th ,,	,,	,,	
75th ,,	,,	,,	
60th ,,	,,	,,	
W Corps Signal Co.	Desert Mtd. Cps.	,,	
Bde. Signal Sec.	7th Mtd. Bde.	,,	
,,	Imp. Camel Corps Bde.	,,	
1st Aust. Signal Sqdrn.	Anzac Mtd. Div.	,,	
2nd ,,	Aust. Mtd. Div.	,,	
Yeomanry Mtd. Div. Sig. Sqdrn.	Yeomanry Mtd. Div.	,,	

JERUSALEM. 7TH TO 9TH AND 26TH TO 30TH DECEMBER, 1917.

Unit.	Formation.	Remarks.
XX CORPS.		
65th Field Co.	10th Div.	E.
66th ,,	,,	,,
85th ,,	,,	,,
436th (Welsh) Field Co.	53rd Div.	,,
437th ,,	,,	,,
439th (Cheshire) Field Co.	,,	,,
519th (London) Field Co.	60th Div.	,,
521st ,,	,,	,,
522nd ,,	,,	,,
No. 5 Field Co. R.M.R.E.	74th Div.	,,
No. 5 Field Co. R.A.R.E.	,,	,,
XXI CORPS.		
484th (E. Ang.) Field Co.	54th Div.	,,
486th ,,	,,	,,
495th (Kent) Field Co.	75th Div.	,,
496th ,,	,,	,,
No. 10 Co. 2nd Q.V.O. S. and M.	,,	,,
DESERT MOUNTED CORPS.		
2nd Aust. Field Sqdrn.	Aust. Mtd. Div.	,,
ARMY TROOPS.		
14th Army Troops Co.	XXI Corps	,,
220th ,,	XX Corps	,,

SIGNALS.

JERUSALEM. 7TH TO 9TH AND 26TH TO 30TH DECEMBER, 1917.

Unit.	Formation.	Remarks.
V Corps Signal Co.	XX Corps	E.
10th Div. Signal Co.	,,	,,
53rd ,,	,,	,,
60th ,,	,,	,,
74th ,,	,,	,,
U Corps Signal Co.	XXI Corps	N.E.
54th Div. Signal Co.	,,	,,
75th ,,	,,	,,
W Corps Signal Co.	Desert Mtd. Cps.	N.E.
2nd Aust. Signal Sqdrn.	Aust. Mtd. Div.	E.

JAFFA. 21ST TO 22ND DECEMBER, 1917.

Unit.	Formation.	Remarks.
XXI CORPS.		
410th (Lowland) Field Co.	52nd Div.	E.
412th ,,	,,	,,
413th ,,	,,	,,
484th (E. Ang.) Field Co.	54th Div.	,,
486th ,,	,,	D.
14th Army Troops Co.	XXI Corps	,,

SIGNALS.

JAFFA. 21ST TO 22ND DECEMBER, 1917.

Unit.	Formation.	Remarks.
U Corps Signal Co.	XXI Corps	N.E.
52nd Div. Signal Co.	,,	E.
54th ,,	,,	,,

PROFESSIONAL NOTES.

GOVERNMENT BUILDING RESEARCH STATION.

First Report of the Building Research Board for period ending 31st December, 1926, together with Notes on the causes of decay in brick and stone work due to the destructive action of the weather.

A SHORT history of the origin and activities of the Board is given in the Report, followed by the policy now governing investigation. These were outlined in the March number of *The Royal Engineers Journal*. It must be explained that investigation into metals is being made by another branch of the Department of Scientific and Industrial Research, and is not included in the purview of this Report.

In order to develop a Science of Building, it is suggested that the programme of work should be formed round a fundamental classification of building materials. They can be considered as falling roughly into three groups, *i.e.*:

(1) Materials in the form of crystalline aggregations (granites, marble).

(2) Materials in an amorphous state (glasses, slags); these are more or less unstable, and will, if opportunity arises, tend to become crystalline.

(3) Materials in a quasi-solid (colloidal) state, (timber, cements, glue): the properties of this class depend upon the amount of water in association, thus, "when a dry specimen absorbs water there is an expansion, a loss of strength and a change in the stress-strain relationship." It would seem that there should be "co-efficients which will directly express the relationship between the physical properties of the material and its moisture content." This idea is being worked out by the Board.

One of the most important problems, however, which are engrossing the attention of the Staff, is that of the resistance of building materials to the destructive effect of exposure to the atmosphere and the weather. What opposition can they make, and how can it best be augmented? The Building Research Station is carrying out experiments to investigate the mechanism of weathering, and to devise quick tests for resistance.

There are many recognized causes of the decay of the stonework and brickwork in buildings, such as :

(i) erosion by the wind, assisted by dust particles ;
(ii) movement due to change of moisture content and/or temperature ;
(iii) expansive action of frost on water held in the pores of the material ;
(iv) attack by bacteria ;
(v) chemical solvent action ;
(vi) the slow crystallization of salts held in solution by acids in the water retained in the voids of the material.

The Stone Preservation Committee of the Building Research Board has been busy with tests and research in this subject for some time ; it has now been " merged into the Standing Chemical and Weathering Committee."

Of the causes of weathering mentioned above, wind erosion is not considered amongst the most serious.

Research is proceeding with movements brought about by changes of temperature and moisture content : a rising temperature may produce an expansion, while the drying out due to that rise may induce a contraction, though there must be a lag in the induced effect, and this would probably be even more marked when the temperature of the specimen is being lowered. For instance, in the case of cements the hydration products are in the form of gels, and " the amount of water associated with these gels, if given time, adjusts itself to the surrounding humidity conditions." Conversely, any unhydrated particles of the clinker " may react with surplus water long after the mass has set." The cracking of neat cement is due to the shrinking movement that takes place when it hardens in the atmosphere, and the amount of shrinkage depends upon the amount of water in the mix. When sand is added, the shrinkage takes place round the inert particles, and these minute movements are not, as it were, added up into one large crack, but are so disconnected as not to signify. The inert particles, assisted by the tiny air pockets in the mix, tend to reduce the rate of evaporation of the moisture, and consequently to reduce the sum of the strains imposed around them, and prevent serious cracking. The great importance of reliable data as to the formation and existence of cracks in cement, lies in the fact that they are the primary causes of weathering of this material : " if water cannot get in, then soluble salts cannot be washed out, nor can the embedded steel be attacked. When water does get in and wash out salts which can crystallize in the cracks, forces are introduced which cause the cracks to widen, often exposing unhydrated particles of clinker, which then hydrate, causing further straining." It has been found that " in most cases the trouble has been due to insuffi-

cient care in the use of mixing water." Research bears out the essential value of a dry mix, because it reduces the resultant strains caused by moisture movement and the initial formation of shrinkage cracks.

Speaking generally, the effect of frost action on building material in this country is not thought to cause as much damage as other agencies; this unavoidable affliction is, however, being pressed to yield its secret.

Experiments show that "bacteria can penetrate stone at the surface, which is exposed to air, but that, in the majority of cases, penetration does not extend beyond an inch below the surface." But though "bacterial fluid suspension in contact with the polished surface of marble will effect an erosion of the surface demonstrable in so short a time as three weeks," and though "fungoid growths and lichens have been known to attack the surface of glass," the investigations into this branch of the science are still in the initial stages. But although chemical solvent action does take place, by far the most potent cause of decay, under modern conditions of smoke-laden air, is the last agency mentioned on the list, namely, crystallization such as would be caused by the conversion of calcium carbonate into calcium sulphate by sulphur dioxide when in the presence of water. This corrosive action is caused by small quantities of sulphuric acid, and also sulphurous acid and ammonium sulphate, when dissolved in rain water as it passes through our polluted atmosphere.

A type of the mechanical action which takes place is as follows:—rain, while falling through the smoky atmosphere, dissolves a certain amount of sulphuric acid: it falls on the surface of limestone, and is absorbed into the external pores to a depth of about a quarter of an inch. A slow chemical change then begins to take place, converting the calcium carbonate into calcium sulphate. In due course, when the water is evaporated out of the surface pores, the calcium sulphate crystallizes just below the surface of the stone; in crystallizing it suddenly expands, like water congealing into ice, with the result that the surface layer of the stone is eventually flaked off, and falls, leaving a pocket, into which more contaminated rain-water may soak during the next shower. The crystals of calcium sulphate may be seen in little white clusters on the freshly broken surface. These crystals seem to grow in families, and it is the persistent collection of fresh growths, each adding its little outward pressure, that ultimately pushes off the flake of stone. Magnesium sulphate has the same effect in the case of sandstones and is the cause of a great deal of the damage to the fine exterior decorations of the Houses of Parliament.

In some cases, the destruction seems to have begun a long time ago, then to have ceased for a period, and then to have begun again. This appears to be the result of re-infection from new mortar used in repairs to the old work. The fresh decay is attributable to a local increase of

calcium sulphate, caused by any excess of lime in the new mortar being washed into the neighbouring stone, or drawn there by capillary attraction, and later being converted into the destructive $CaSO_4$ crystals. In like manner, decay in brickwork is generally caused by infection from the mortar in contact with it.

The path taken by invading liquids is being traced by means of coloured resins. Sections of the material, at varying depths from the surface, show the process of decay at work, including both the solution of the material in the solvent as well as the formation of the hostile sulphates. The key to the trouble seems to lie in the flow of this solution : " if evaporation takes place more readily from one portion of a surface than from another, a flow of the solution will take place towards that portion, and the crystallization will be there more pronounced." For this reason old mortar in walls, being very porous, offers the easiest surface for evaporation, and is often found to become loosened and fall out. But when, as a result, that porous mortar is replaced with a denser cement, the flow is reversed, and the consequent crystallization takes place in the brick or stone near the new cement joint. The reason is that " the salts which give trouble sometimes come from the mortar itself. Free lime is usually present, which water can dissolve and transmit to the structure ; this lime, when acted upon by atmospheric acids, frequently causes efflorescence, and sometimes decay. Even with Portland cement, this trouble may occur, as lime is set free on hydration of the cement."

" The remedy suggested is the use of a pozzolana. A substance may be called pozzolanic when, while not necessarily cementitious by itself, it possesses constituents which will combine with hydrated lime at ordinary temperatures in the presence of moisture to form stable insoluble compounds of cementitious value."

Pozzolanas are used far more on the Continent than in this country. They were also in general use at the beginning of the Christian era.

When the writer was excavating the foundations of the old Roman fort near Alexandria in Egypt, it was most noticeable that the lime mortar joints were often stronger than the bricks or tiles of the structure, and that, if a mass of the material were fractured, the break would occur across the aggregate rather than along the mortar joints. The secret has been found to lie in the successful use of a pozzolana in conjunction with properly slaked lime.

It is possible to-day to obtain a lime-pozzolana mixture, which will vie with any of these old mortars in strength and endurance : the long-hidden secret being the neutralization of free lime, which is then unable to combine with sulphur and other impurities to form destructive crystals. A stable insoluble compound of adhesive property is formed instead.

Naturally, for economical reasons, this pozzolana should be produced locally, either from a natural or an artificial source.

These sources can roughly be classified as under :—

Natural pozzolanas, such as :

Italian pozzolanas.
Santorin earth (Greek).
Trass (Rhine and Bavaria).
Volcanic ash deposits (S.E. France, Azores, Canaries, Japan).
Diatomaceous earth (Scotland, Ireland, U.S.A., etc.).

Artificial pozzolanas, such as :

Granulated blast-furnace slag.
Crushed bricks and tiles of certain kinds.
Burnt " surkhi " or Indian clay.
Furnace clinker.
" Si-stoff," or residues from continental alum manufacture.

Dual type pozzolana, such as :

Gaize, a natural silicious material from the Ardennes. Spent oil-shale has also yielded results that appear to be promising : this source is being investigated.

The natural pozzolanas are mostly of volcanic origin.

There is a British Standard Specification (No. 146—1926) for Portland blast-furnace cement.

Clay products lose their pozzolanic activity if burnt at too high a temperature, and certain clays are unsuitable. If clay has to be excavated in any quantity on the site of works, the possibility of producing a good pozzolana for future constructional purposes would amply repay experiments in burning. A pozzolana should be ground no less finely than ordinary Portland cement.

The actual effect of the pozzolana is to combine with the lime to form insoluble silicates and aluminates : the mortar can then set and acquire hardness even under water or in such damp positions as the centre of a mass of masonry, where pure lime mortar might not set satisfactorily. It is said by Continental engineers that Portland cement concrete would not appreciably lose strength if 30 per cent. of the cement were replaced by trass ; on the other hand, its impermeability to fresh or sea water is markedly improved : " also the resistance of Portland cement to injury by severe heating can be materially increased by pozzolanic addition."

Further information on the use of pozzolanas can be obtained from *Building Research Bulletin* No. 2.

In connection with this research work of the Building Research Board, it may be of interest to know that experiments into the causes and possible cure of the destructive effect of weathering on

building materials are also being separately carried on by other investigators.

Professor Laurie, M.A., B.SC., has also been conducting careful and extensive tests and observations all over Great Britain, with the view of finding the causes and most suitable cures for this profitless destruction, which is wasting some hundred thousands a year.

He has found that, if a piece of sandstone is soaked in a salt solution, and then covered on all its faces but one with vaseline, and if that one free face be alternately wetted and dried, fresh salt will keep on crystallizing out of this face. This experiment sounds obvious, but when considered and acted upon, it has a very important result. The vaselined faces may be regarded as the stone surfaces which are bedded into a building, leaving one surface free to the weather. By alternate spraying and drying, fresh crystals can be made to form on the exposed face, and subsequently removed by the washing. This process can be continued till the stone is washed free of salt.

Experiments on a variety of limestones also showed that they can be washed free of the deleterious salts. The face of a calcareous stone in the neighbourhood of London was washed out in like manner with a watering can on four successive days : the subsequent analyses showed the removal of a considerable percentage of calcium sulphate. In another experiment he covered the only free face of a saturated stone with Portland cement, and then carried out the alternate spraying and drying as before. But this time the crystallization took place behind the cement covering, which was finally detached, disclosing a film of rotted stone below the crystals.

Professor Laurie's own deductions are that " this is due to the fact that, owing to the alteration of surface tension on concentration for most salt solutions, if the capillaries have only one surface of evaporation, the solution is drawn out of the capillaries to that surface, and the salts deposited there. The rain brings with it sulphurous and sulphuric acids and ammonium sulphate, all of which attack calcium carbonate, but at the same time the rain is dissolving out the calcium sulphate, and so tending to prevent crystallization inside the stone. For this to be effective, a stone is required in which the evaporation is rapid." For in that case a balance is set up between the accumulation by chemical action and the removal by washing out of the calcium sulphate or other deleterious salt. He found this deduction borne out in regard to the parapet of Ketton stone outside Westminster Hall, and the stone in some parts of Lincoln Cathedral. The aggregate decay has been practically brought to a standstill in the cases of these stones of high capillary power. In an experiment carried out on four limestones it was found that Portland stone gave the best results in rate of absorbing water and drying out. Perhaps this is why it resists London's atmospheric conditions better than any other stone.

Sulphur dioxide can be carried over long distances in the air, as is proved by the weathering at Ely Cathedral and Tintern Abbey, both far from centres of population and the resultant smoke.

All these experiments point to the danger of treating a building material, which shows signs of decay, with any covering which will close the pores. It is sounder to wash the external face of a building thoroughly than to cover it with any preservative which tends to impede free evaporation. When a building shows signs of decay from weathering, it seems, at present, a much more efficacious policy to assist the beneficial action of the rain, and wash down the faces so attacked; this treatment should be carried out in the summer to ensure quick evaporation. Allow them to dry out and wash them again two or three times if possible. This method has proved its efficacy at the Goldsmiths' Hall, in London. It has been washed down two or three times a year for the last thirty years, if not longer, and all signs of incipient decay seem to have been stopped. But similar treatment for interiors is questionable as yet; it would be better to begin by replacing gas by electricity, and suspicious heating installations by up-to-date scientific ones.

One of the dangers which is now being investigated at the Building Research Station, and which has been referred to above, lies in the use of a mortar containing small quantities of free lime, and which is harder and has a smaller porosity than the fabric of the building to which it is applied. The fabric, which then has a greater porosity, will suck the injurious salt out of the mortar, and fall a victim to its own powers of absorption, unless the poison is satisfactorily washed out before the crystals have had time to collect in dangerous quantities.

But if we can bring into play a sort of architectural jujitsu, and make this very power of absorption act as an ally instead of an enemy, we can force it to cast out the poisonous chemical compounds in time to save the structure from unsightly stigma if not from actual decay.

Some day, perhaps, the presence of either will be considered as a similar stigma on the technical reputation of the architect.

D. M. F. HOYSTED.

THE REVIVAL OF A WAR TROPHY TANK.

IN April, 1926, the School of Electric Lighting was requested (through the C.R.E., Wessex Area East), to see if they could move a 30-ton Mark V Daimler-engined Tank, which had been presented to the borough of Portsmouth as a war trophy, and placed in position at a cross-road near the Clarence Pier in August, 1919. The tank had since been found to be a danger to motorists, as it obstructed the view. It was understood that a firm of haulage contractors, which had

undertaken to move the tank by means of a steam tractor, had been unable to do so.

A preliminary examination showed all unpainted metal parts inside the tank to be very badly rusted, after six-and-a-half years' neglect. An oil-can, which had been left in the tank, crumbled away at a touch; the autovac tank was rusted through; the sparking plugs had been removed, allowing damp, grit, and rust to get into the cylinders; the main and the hand-starting magneto, also the carburettor had been removed; all the water joints were badly perished.

However, as is our usual good fortune in the Corps, a specialist in this particular line was available. Serjeant Rickards, R.E., who had served formerly with the Experimental Bridging Establishment, Christchurch, informed the writer that he could get the necessary hand-starter magneto and the 6-cylinder magneto, carburettor, spare track pins, etc., from Christchurch, for this obsolete make of tank. He obtained the same within 24 hours.

To our surprise, the engine was found to be quite free. It was turned over by hand several times, to ensure that everything was in order, and to start the oil circulation. The ignition was then connected up, and the engine started without much difficulty (with three men on the starting crank, and using a hand-starter magneto).

The 105 H.P. Daimler double-sleeve-valve engine was of the dry-sump type (in order to avoid lubrication trouble when the tank is tilted to steep angles when crossing rough ground). For the first two or three minutes after starting up, the sump oil extraction pump was delivering practically pure water out of the oil sump into the oil reservoir, proving how damp was the atmosphere in which the tank had been left, without being touched, for over six years.

The compression was quite good, and the engine ran quietly, without misfiring, with a clear exhaust.

When the gears were engaged, the tank began to drive on one track only, and it was found that one driving pinion had been removed. Another driving pinion was, however, soon obtained from a similar war trophy tank at Gosport. The tank was then successfully manœuvred into its new position, which was at an angle to the former site and a few yards away.

The two R.E. N.C.O.s employed showed, as usual, great energy and initiative in overcoming various minor difficulties. It was most fortunate that an N.C.O. experienced in the driving of this type of tank was available.

The chief lesson would appear to be the remarkable persistence of the oil film on the working surfaces of a sleeve-valve-engine. It is unlikely that a poppet-valve-engine would have held its compression after such a long period of neglect.

J. H. DYER.

BOOKS.

A.Q., OR MILITARY ADMINISTRATION IN WAR.

By LIEUT.-COLONEL W. G. LINDSELL, D.S.O., O.B.E., M.C., *p.s.c.*, R.A.

(Gale & Polden, Ltd., Aldershot.) 8s. 6d. net.

It is always interesting to examine the result when a complex is taken out for an airing by its owner. When that owner is an expert, interest is converted to admiration.

Even without the thirteen letters of the alphabet that follow his name, Lieut.-Colonel Lindsell could lay claim to the title of expert on the strength of his *Military Organization and Administration;* this volume substantiates his claims in full.

It is unfortunately true that most officers are only lured into the perusal of a volume on administration for the purpose of satisfying an examiner; those that turn to this volume for that purpose will get full value for their pains. But, luckily, the necessity for passing examinations, *ipso facto*, leads many on to the serious study of their profession. For these, *A. and Q.* will prove a mine in which every page will provide a spadeful of rich treasure. No one could read this volume without appreciating the great truth that sound administration is the basis of all military operations, and he who assimilates the knowledge therein can fairly claim to be competent to tackle the problems he might be called upon to face in war. But Lieut.-Colonel Lindsell does not merely satiate our memories with data, at times he makes advances into the fields of deductions, and in these fields offers a challenge to the powers of the reader. For example, he makes the statement, "The more we consider these big administrative problems, we come nearer to the conclusion that modern wars of the continental type are no longer won by decisive battles, but by sustained and adequate maintenance arrangements."

By "decisive," we understand battles that end a war, such as Waterloo or Jena. It is for consideration whether the true reason for the absence of decisive battles in the Great War did not lie in the lack of appreciation of the enormously enhanced powers conferred upon the defensive by the machine-gun. That balance appears on a fair way to be restored by the development of the armoured fighting vehicle.

The man and the horse can subsist for a definite limited period on inadequate supplies, but the petrol-engine will not give a single revolution without its bituminous rations; so would it not be more accurate to deduce that decisive battles are still possible, but are more and more dependent upon adequate administration?

As a concrete illustration of the dependence of strategical operations upon administration, Lieut.-Colonel Lindsell gives a long review of the Palestine campaign. No better example could have been chosen, for in Palestine every strategical conception hinged upon supply, while rarely has there been a more marked instance of troops in the full tide of success being compelled to call a halt, than when Allenby's troops had to stay their advance after the capture of Jerusalem. For, as Colonel Lindsell puts it, " the army had outrun its communications, and further advance was impracticable until these communications could be got into proper working order."

Now, this campaign is invariably used by the conservative school in the British Army as the great argument in favour of retaining the mounted arm in its full pre-war proportions.

It is sometimes questionable as to whether value can be obtained from an examination of suppositions. " If only," the scoffers say, " some slight structural alterations could be performed in the anatomy of my aunt, she would then become my uncle."

Still, it would undoubtedly have been of the utmost interest if Colonel Lindsell had seen fit to have examined the possibilities of armoured fighting vehicles as a component of the Desert Mounted Corps. We would all like to hear whether an administrative expert considers that the great turning movement of the Desert Mounted Corps at Beersheba or at Megiddo were possible or not for a force such as the experimental Brigade now collected at Tidworth.

For convenience of reference, it is hoped that the inevitable reprint of this volume will be provided with an Index.

R.H.A.

THE FUTURE OF THE BRITISH ARMY.

By Brevet-Major B. C. Dening, m.c., R.E.

(Witherby, 10s. 6d.)

In this book the author sets out to study the problem of the British Army: its duties, cost, and composition. Writers on such subjects are generally classed as " tank maniacs," or " bow-and-arrow men." Major Dening would probably be placed in the former class, though his views are not so extreme as some we have seen, and he fully recognizes the necessity of gradual progress.

As a foundation for his theme, the author makes a rapid survey of the wars of the last fifty years, and shows how success in each was due to some new factor, such as railways in the Franco-German War. The arguments regarding these factors are sometimes rather unexpected. For example, the Russo-Japanese War is said to show that the defensive, aided by machine-guns and barbed-wire, was quite unshakable by any but siege methods of attack. The Manchurian Plains, where manœuvre was possible, are excepted. But surely the history of the War showed that, except under siege conditions at Port Arthur, manœuvre generally was possible and, being possible, was employed. At Mukden, even

though the final retreat was caused by the flank attack against the Russian left, several successive positions had been captured by the Japanese frontal attacks.

Again, we cannot follow the author's arguments in every case in his consideration of the Great War. Having shown that Cambrai demonstrated the necessity of protection from small-arm fire, he proceeds to deal with the German attacks of 1918. He says: "Though special circumstances on the Somme, the Lys, and the Chemin des Dames, enabled large advances to be made, inevitably, as soon as a line of some sort was drawn against the attack outside the immediate zone of super-bombardment, the unprotected infantryman was no match for the concealed defender, and the war of motion came to a definite stop." Such special pleading, in view of the enormous German advance, tends to make the reader place the author in the ranks of "tank maniacs," perhaps unjustly. He also fails to deal with the argument of the "bow-and-arrow" specialist, who points out that even in the great British advance of August 8th, 1918, when the Germans were not specially endowed with anti-tank defence, the tanks suffered a very large percentage of casualties.

Having dealt with the past, we are led into the future, and it is asserted that wars of the future will be carried out by small mechanized armies, small because one cannot afford or provide large mechanized forces, and mechanized for the purposes of mobility, and armoured protection. The "bow-and-arrow" man will ask the effect on such a force of an enemy of large numbers well endowed with anti-tank weapons, which may have its flanks as secure as those in the Great War. These examples are quoted to show that the opening considerations are not "bow-and-arrow" proof. True, they do not form the main thesis of the book, and, therefore, the author doubtless has purposely limited his arguments to a minimum in order to expend his main effort on a consideration of the composition of the future army and how it is to be produced.

We must be grateful to the author for his presentation of a complete scheme, and though various readers will disagree with certain points, all will agree that here at least we have a complete scheme, and not a patchwork of ideas.

The composition of the force is that given by Major Dening, in his essay which was awarded the Bertrand Stewart prize, in 1924. Even in the few years that have elapsed since the essay was written, much water has flowed under the bridges of military reorganization. Nevertheless, the organization is, in principle, well considered and reasonable, though, like all such attempts, it would have many critics. How this force is to be produced is next considered, with due regard to the needs of the British Empire, the Cardwell System and finance.

As regards the first two, difficulties are faced, and established institutions treated with the respect due to successful operations in the past. It is when he deals with finance that the author treads on more dangerous ground. Many Appendices are given to support arguments, but the essence of true financial argument depends on a close knowledge of how basic figures are arrived at. This we cannot feel the author can claim to have. The figure £120 for the cost of an infantryman is not

dissected in estimates, and we do not know how much, if any, of this figure accounts for equipment, housing, overhead expenses, etc. Without such a knowledge the use of the figures is dangerous.

The author is also forced to make assumptions for cost of spares, upkeep and depreciation of armoured vehicles, as well as extra personnel for maintenance. Such figures are extremely difficult to come by with any degree of accuracy. The abolition of men and units is claimed to produce savings on a *per capita* basis. Financial experts assure us that such calculations are not reliable.

Altogether, while commending the author for his desire to produce a scheme of reorganization which is financially possible, we must regret that he has endeavoured to make such a detailed financial investigation based on data, about the basis of which so little is known by the ordinary student of army estimates. The author may be fairly right in his estimates, but we cannot feel his financial picture is a sound one, and we would rather the cobbler had stuck to his last, and treated the subject from a purely military point of view, completing his military arguments in more detail, and contenting himself with balancing in general terms savings in old-fashioned units against expenditure on mechanization.

The author who undertakes the writing of such a book as this cannot expect to please critics, and deserves recognition for his courage. Most military readers and civilians, who are sufficiently interested to study the matter, have pet ideas of their own. All the more, therefore, Major Dening deserves every credit for the production of a complete and fully reasoned plan, which all should study, and which will help to focus the ideas of tank maniacs and bow-and-arrow men alike.

R.P.P-W.

OUDH IN 1857.

Some Memories of the Indian Mutiny: by COLONEL JOHN BONHAM, C.B. (Williams & Norgate. 5s. net.)

The author of this little book of 95 pages is the last surviving officer of the Defence of Lucknow, and is in his ninety-fourth year. The last 20 pages only of the book give the personal experiences of the author, and bring the story up to his arrival at Lucknow from Secrora, before the Battle of Chinhut had been fought; this battle was followed by the investment of the Residency position at the end of June, 1857. It had been the author's intention to continue the story of his experiences, but a serious illness frustrated his design. The book gives a vivid picture of what the Europeans, men, women and children, in the out-stations in Oudh, underwent on the outbreak of the Mutiny.

Oudh was annexed in February, 1856. The story of the misrule and anarchy in the Province which led up to this act is well known. To carry out the annexation and guard against disturbances, there was an Army of Occupation, consisting of troops of the Regular Native Army. The intention was to withdraw this Army as soon as the organization and equipment of the Oudh Irregular Force, which was to form the garrison of Oudh, were completed. This Irregular Force consisted of 3 batteries of artillery, 3 regiments of cavalry, and 10 regiments of

infantry, and was recruited from the disbanded soldiery of the late King of Oudh.

It thus happened that the number of native troops (as they were called in those days), Regular and Irregular, in the Province, was excessive at this time, and amounted to 760 artillery with 30 field-guns, 3,400 cavalry, and 16,400 infantry. The only European troops were H.M. 32nd Regiment (800), and 1 field-battery of artillery (75). But for the presence of the regular native troops, it is probable that affairs would have followed a different sequence in Oudh, and the dreadful tale of massacre of Europeans in the outlying stations would not have had to be told. As it was, station after station caught the infection, and at Shahjahanpore, Mohunudee, Chobeypore, Seetapore, Fyzabad, Sultanpore, Salone, Durrabad, Gonda, Bareytch, and Secrora, the troops mutinied, officers were shot down on parade, and those who made their escape, often with the women and children, too often met their end at the hands of stray bands of mutineers. Very few indeed arrived safely at Lucknow, to undergo later the hardships of the Siege.

This book is an interesting addition to our literature on the Mutiny.

P.H.K.

BIG GAME SHOOTING IN THE INDIAN EMPIRE.

By LIEUT.-COLONEL C. H. STOCKLEY.

(Reprinted, by permission, from *The Times Literary Supplement.*)

(Constable. 18s. net.)

India has been famous for its variety of big game since the day when the first European set foot on its shores. Sportsmen who have either been unlucky in their heads, or have returned with no trophies, speak of India nowadays as shot out. Anyone, however, reading this book will soon realize that this is not so in reality, although game has no doubt diminished in certain districts within the last fifty years. Colonel Stockley's object was to produce a general book on big game shooting in India, at a price within the reach of the ordinary soldier-sportsman. He has achieved his end and has written an excellent work, giving an idea of the appearance and habits of the various species and the best way of setting out to shoot them. The choice of a shooting-ground in Mysore, Central Provinces, Assam, Burma and other places, is carefully discussed, taking everything into consideration, in particular the means and time at the disposal of the sportsman. Dealing with Burma, the author rightly points out that the language difficulty is more acute there than anywhere else in India. In his opinion, there is no finer country for the experienced man, but wisely discourages the novice from proceeding thither.

One of the finest shooting districts in India is, without doubt, the Himalayas, to which a special chapter is devoted. Those who have shot in the Himalayas will find it difficult to agree with the author, who says that there " the actual bagging of a good head does not entail such a high degree of efficiency in the science of finding and following the quarry, as does tracking dangerous game." Kashmir, the Mecca of

mountain sport, is dealt with first. Astor, Ladakh, Baltistan, Zanskar, Kishtwar, and other districts, are later described, with particular attention to such all-important matters as supplies and transport. The rules about the number of guns allowed and the special licences required are explained. Curiously enough, Baltistan, one of the largest districts, has only a small paragraph devoted to it. The author mentions as a fact that here there are still plenty of good ibex to be found, though no doubt the more famous *nullahs* have been shot so regularly for many years that they no longer yield big heads. A general observation is made to the effect that *nullahs* off the beaten track might be tried with success. No definite locality is mentioned, and areas around Askole might with profit have been suggested. This region, no doubt, has the disadvantage of being a long way from Srinagar; but those who can afford the time will be well advised to try *nullahs* there, where recently heads of over 50 inches have been reported. One cannot fail to notice that, though the difficulties of shooting in the Himalayas are referred to, no mention is made of the effect of altitude. This, it will be found, becomes very trying, especially if any effort has been made to reach a suitable point from which to fire—the sportsman finds himself breathless, and consequently unable to steady the rifle.

The question of the selection of a rifle is one on which there is a great variety of opinion, and experts differ to such an extent that a choice of a rifle must become a personal matter. A chapter is devoted to this subject, in which useful information is given, not only on various makes, but on the errors of the beginner, all of which, however, can only be overcome by experience. The sportsman up to now has had assistance in selecting his shooting-ground, and in purchasing his rifle. There still remain the camp outfit and stores to be considered, which vary according to local supplies. A useful hint for Burma is given (frequently omitted in books) about milk which must be taken in tins, as the villagers do not milk their cows. Camp kit and equipment, cooking pots, etc., are mentioned in detail and serve as a useful guide, though not necessarily to be rigidly followed. The author ends Part I of the book by chapters on stalking, tracking, beating and the disadvantages of sitting up at night for game, ending with a final chapter on skinning and preserving trophies. This is particularly valuable, as so many skins are ruined in out-of-the-way places through lack of elementary knowledge on this subject.

Part II consists of accounts of individual species, which are not, however, intended to be zoological treatises. They will give the beginner an idea of the appearance and habits of animals and where they are generally found. There are fifty-four species dealt with, and the fact that the author has shot thirty-six of these and has personal acquaintance of eight more, will surely satisfy the most ardent critic of his authority to write a book such as this. He has a pleasant style which is easy reading, and a welcome feature is that he contents himself with generalizing on the habits of wild animals, leaving it to the novice to dogmatize. There are a large number of excellent photographs, chiefly of the different species, which have been well reproduced. There is also a small map of India showing the shooting districts, and a good Index.

NATIONAL POLICY AND NAVAL STRENGTH.

By VICE-ADMIRAL SIR H. W. RICHMOND, K.C.B.

(Reprinted, by permission, from *The Times Literary Supplement*, 21st June, 1928.)

(Longmans. 16s. net.)

The very qualities of this book make it difficult to review. It is hard to discuss a survey of naval policy with which it is not possible to disagree, and which is presented with such force and knowledge. Any remarks that can be made must be regarded as an invitation to the author to write again upon the same subjects.

Whenever Great Britain goes to war, either on her own resources or as a party to a Continental alliance, the Government is automatically confronted with a difficult and baffling question of high policy: Can the enemy be reduced to terms solely by subjecting them to economic duress applied from the sea? If this will not in itself be sufficient, what commitments ought to be undertaken on land? Admiral Richmond's essays are in the nature of commentaries upon this perpetually recurring problem. It is not a mathematical problem susceptible to a hard-and-fast solution: the variable quantities are too numerous; but it contains certain constant data, which Admiral Richmond has endeavoured to disengage and tabulate. His conclusions are roughly these: When Great Britain engaged in the war of the league of Augsburg it was no longer open to her to wage war purely as a maritime Power. Holland, the one rival which could be reduced from the sea, was no longer an enemy. The Continental alliances to which Great Britain was henceforth a party, had necessarily to be supported by armies sent to the Continent, or there raised and supported by British treasure, and controlled by British generals. Also the accession of the Hanoverian dynasty made it almost impossible for Great Britain to intervene in Continental quarrels as a purely oceanic Power. None the less, the consequences of these political obligations were always considered irksome by certain sections of the British nation. Admiral Richmond shows how almost every war Ministry in Great Britain has been either tempted, or urged, to make an enemy's trade and colonies the first objectives of its higher strategy, and to undertake as few other military responsibilities as possible.

In the last War, the problem reappeared in a rather different shape. Nobody suggested that the central Empires could be reduced by occupying their colonies; the nation felt, instinctively, that large armies must be sent to the Continent if the War were to be won. None the less, that complex of measures known as the blockade of Germany was the modern equivalent of the old campaigns against an enemy's "plantations and trade." It was that economic isolation of an opponent which Dundas had vaguely hoped to inflict, by other means, rather more than a hundred years before. By a singular misfortune the terrible effects of the economic campaign against the Central Empires were persistently belittled in the Press and Parliament. It was represented as an ill-managed auxiliary campaign; and it was not until

the War was over that experts were able to assess its military value. Had it been realized early that the economic pressure which Great Britain and her Allies could exert unaided would reduce the German nation to the utter distress of the turnip winter of 1916, then, presumably, this old problem of co-ordinating military and naval action would have been seen in a better perspective. It would then have been grasped that the economic campaign—the heir-at-law to the old sugar islands warfare—was, perhaps, the most powerful military weapon in our hands; it would have been realized, also, that it could be strengthened by extraordinary military exertions in certain theatres. Those theatres would, presumably, not have been the ones that were actually selected. However natural it may have seemed at the time, it is impossible, in the present state of our knowledge, to justify a higher military strategy which took no account whatever of the economic campaign. It was, after all, rather paradoxical that entire British armies should have been devoured in the casualty lists of the Somme and Passchendaele battle-fields, while the enemy restocked themselves in Rumania and the Ukraine.

This digression has slightly separated us from Admiral Richmond's subject. His purpose is to show that the great campaigns in France were not undertaken in defiance of historical tradition. They were necessary in themselves, they were practical applications of a constant rule of English policy, that armed intervention on the Continent shall be made on a scale proportionate to the strength or weakness of Great Britain's Continental allies. We agree; but suggest that the proved results of economic warfare have given new life to an old doctrine. It can now be argued that the economic and industrial strength of the British Empire, its merchant fleet, its coaling stations and its military strength at sea can be used co-operatively for isolating an opponent: that British armies which assist an ally to complete a partial commercial encirclement of an enemy may be deemed necessary: but that armies which divert our unique national resources from their proper military object are a mere dissipation of strength.

Admiral Richmond's examination of German naval strategy during the War leads him to the conclusion that the high naval command in Berlin and Wilhelmshaven persistently neglected their opportunities. The German Fleet should have been ruthlessly, unsparingly used to prevent British armies from landing in France in 1914, and to stop the flow of British reinforcements during the disasters of 1918. It is impossible to dispute the first of these two conclusions: the second appears at least arguable. If reinforcements to France in 1918 could have been stopped, it would only have been by prolonged operations. Spasmodic interruptions of cross-Channel traffic were by then weekly occurrences. Ports were closed for short periods whenever submarines were particularly active: they were reopened as soon as the operating submarines had moved on. These spasmodic interruptions, which were frequent during March, April and May, 1918, never seriously affected the flow of transports and supplies to France. A very much longer interruption would have been necessary to deprive the British armies of reinforcements and supplies at a critical time.

Admiral Richmond is inclined to think that blocking expeditions and powerfully supported raids would have caused a prolonged interruption in the flow of supplies; but it is difficult to believe that this would have been sufficient. Surely nothing but a protracted naval occupation of the eastern half of the English Channel would have caused a real stoppage. It is certainly rather surprising that during these critical months German submarine commanders were paying far more attention to the Irish Sea than to the English Channel, but it seems more than doubtful whether any concentration that the Germans could have effected in the eastern Channel would have sensibly affected the battles in Artois and Flanders.

The closing group of essays are concerned with what may be called the Navy's moral problems. They do not bear directly upon Admiral Richmond's main subject, but the method of treatment is the same. As a writer upon naval policy, Admiral Richmond steadily and powerfully advocates that the skeleton framework of British policy shall be of a genuinely national design. As a writer upon naval education he argues, with equal force, that British naval officers shall be practised in that free open discussion of important questions which is the starting point of our institutions. His plea is unanswerable; and, indeed, very few naval officers would be much inclined to contest it openly. None the less, so few men in high military or naval office have tolerated discussion between themselves and their inferiors that certain habits of thought and conduct which Admiral Richmond severely condemns must, in justice, be regarded more as products of circumstance than as positive vices. Men who are trained to conduct operations at sea or on land feel instinctively that they cannot, and must not, cultivate that mental habit of perpetually suspending judgment which Newman considered to be one of the distinguishing marks of a man of the world. The knowledge that a command from them and absolute obedience from others are the starting points of every military operation weighs heavily upon them. Unfortunately, this perfectly honourable sense of personal responsibility is productive of many dangerous vices. It is responsible for that objectionable admiration for the "strong man" who lives in the imagination of so many naval and military officers; and whose undesirable qualities are so often appealed to as a justification of violent, arbitrary dealing or brutal stupidity. By good fortune this cult of the "strong man" is to a certain extent held in check by our national instincts; it is not likely that it will ever be as powerful in Great Britain as it may be abroad. It is, however, a dangerous and objectionable creed, creative of habits of thought and conduct which are on the whole more likely to spread in a naval and military service than elsewhere.

It is fortunate for the naval service that an officer of high rank like Admiral Richmond should be a powerful and eloquent advocate of the genuinely British practice of free discussion. He has a thorough contempt for the man of action who can explain nothing and defend no argument. He is inclined to think, moreover, that high naval and military officers have in the past been better able to discuss and maintain their opinions than they are to-day. This may be partly explained by the great alterations which have taken place in our social customs. The conversation and discussion in which every gentleman of the seventeenth

and eighteenth centuries was trained from boyhood have been replaced by after-dinner games. The decline of conversational power is general; but, in the Navy, there was an additional reason for it, which it is to be hoped Admiral Richmond will some day examine. In the late seventeenth century, the council of flag officers and captains was almost a floating Department of State. It was convened upon every important occasion. The powers of the council may have been too great, but at least its existence as an institution must have stimulated those qualities which Admiral Richmond considers essential in a naval commander. It helped to maintain a high standard of professional discussion; it accustomed a commander-in-chief to hear and answer opinions contrary to his own; and, presumably, it acted as a check upon some of those vices of thought and practice of which Admiral Richmond is an unflinching enemy.

R. E. CROMPTON: REMINISCENCES.

(Constable & Co.) Price 14s.

This autobiography tells the story of a remarkably full and varied life. The author, who is 83 and still at work, was born near Thirsk, in 1845, his father being a man of independent means. During the Crimean War, Militia battalions garrisoned the Mediterranean stations, and his father commanded one of these battalions that went to Gibraltar. The family went, too, and this led to young Crompton obtaining the Crimean medal at the age of eleven. A cousin commanded H.M.S. *Dragon*, which called at Gibraltar, and the boy was sent with him to the Crimea. He started as a guest, but it was found necessary that he should be enrolled as a cadet in the Royal Navy. He accordingly settled down to life in the Navy, receiving instruction and becoming officer of the Captain's gig. From Karatch he obtained leave to visit his brother, who was in the trenches before Sebastopol, and spent some days with him. As he had actually been in the firing line, he was awarded the medal with clasp for Sebastopol.

After this experience, he returned to school at Elstree and later at Harrow. His engineering bent was shown at Harrow, where he started the construction of a model steam-driven road-engine, and in the holidays a full-sized road-engine was begun.

In spite of this clearly marked bent it was decided that Crompton should enter the Army. Cramming for Woolwich was followed by a very amusing and interesting six months in Paris, which included dancing lessons at the Grand Opera. The Woolwich project was then dropped, and many months were spent on the designing and building of the road-engine. It was during this time that the "differential," since universally adopted, was evolved and applied to the road-engine. It was, however, eventually decided that he should enter the Army after all, and he passed in second in the direct commission examination from a Doctor Laumann's, at whose house, by the way, he had inadvertently sat down upon a Royal Princess!

In 1864, at the age of 19, he was gazetted to the 3rd Battalion of the

Rifle Brigade, and joined the depot at Winchester. He was then ordered to join his battalion in India, and travelled overland from Port Said to Suez, and thence to Karachi. From Karachi, the journey was by steamer up the Indus to Multan, thence by rail to Lahore, and by *dak-gharri* to Nowshera, *via* Rawalpindi. Plenty of hard work, and shooting in the Salt Range and in Kashmir, were followed, in 1867, by a return to his first love, the road-engine. He got out from England his machine-lathe and tools, and the most important parts of his road-engine. This led eventually to the successful experiments with the road-train on manœuvres and elsewhere in Northern India in 1873, an account of which appeared in *The R.E. Journal* of June, 1926. Though these experiments proved to be very successful, the matter was dropped owing to the death of Lord Mayo and to the adoption of the narrow-gauge railway policy. The results of this experience, as far as the author was concerned, were that he gave up soldiering in 1876, and took up engineering as a profession. After following many different lines, he eventually settled on electric lighting as the one to adopt, and it is in this connection that his name is best known. The book contains a history in short of the development of electrical engineering in this country, as witnessed by the author's experiences, from the first low-voltage direct-coupled generator to the modern H.T. distribution, and from the arc light to the incandescent lamp. His early work consisted chiefly of lighting up large areas, such as railway stations and yards, with arc lights, often from portable sets. In 1879, Henley Regatta was lighted up, and caused a sensation. The course of business took Crompton all over Europe, his most notable early contract being for lighting the Opera House and other imperial theatres at Vienna, after the Ring Theatre had been destroyed by fire in 1883. Being made *höfisch*, he was admitted to Court circles; for what the Archduchess said the reader is referred to the book itself. In 1895, Crompton became President of the Institution of Electrical Engineers. Two visits to India then bring the story up to the South African War. At that time, Crompton was the officer commanding the Electrical Engineers Volunteers, which had been raised in 1897. He was asked to raise and equip a detachment of 300 men to supply the electrical needs of Lord Roberts' force. This he did, and landed at Cape Town with his men in May, 1900. On arrival, at the request of Colonel Girouard, Director of Railways, the Electrical Engineers were attached to the railway reconstruction working parties, which had then been formed for keeping the railway communications open. At Leeuwspruit, Lieut.-Col. Crompton defended his construction train against a determined attack by the Boers, and by preventing the railway line from being cut on that day, saved the situation of our army. For this he was awarded the C.B. He was then employed by Lord Roberts on the organization of the various tractors with the Army into a mechanical transport train, and was sent to England at the end of 1900 to try and expedite the expansion of this organization. From 1900 to 1914, he was occupied with road transport work and the improvement of the roads, on behalf of the War Office and the newly-constituted Road Board. In 1915, he was asked to join a committee formed by Mr. Churchill, "to advise methods for attacking and crossing trenches," and he was desired "to assist with technical

advice and to design large armoured and mechanically-propelled vehicles for this purpose, which were then called landships." The various steps in the development of the tank are detailed.

The author sums up the story of his long and active life as the continuous dealing with the problems of distribution. "Beginning in 1869 with the development of steam transport on roads, then starting afresh in 1878 on the generation and distribution of electrical energy, then back through bicycling to road and automobile problems, and finally, in these latter days of my life, occupied with the question of how best to bring electrical energy within the reach of every dweller in the country, it has been the great problem of distribution on which I have throughout been engaged."

P.H.K.

THE UNCENSORED DARDANELLES.

By E. Ashmead-Bartlett, C.B.E.

Hutchinson & Co. (1928.) Price 21s.

The problem of Press censorship in war is a very difficult one to solve. There were so many instances before the Great War of information of the utmost importance being "given away" in the Press that, on the outbreak of war in 1914, the General Staff overlooked the necessity of keeping up the morale of the nation by judicious use of the Press in their anxiety to run no risk of plans, movements, numbers, etc., being divulged to the enemy by inexperienced and untried Press correspondents. As regards the opening phases of the War, it was probably fortunate for the Allies that Great Britain drew the reins so tight. Gradually, however, the restrictions were relaxed, and as a result Mr. Ashmead-Bartlett was accepted as one of the two special correspondents who were permitted to accompany the Dardanelles Expedition. An ex-Press-correspondent, Mr. William Maxwell, who had represented *The Daily Telegraph* in France and Belgium, was appointed Press Censor, with the rank of Captain in the General Staff.

The reader has to tread warily in accepting the author's statements and criticisms. Much of the narrative is based on second-hand information, picked up on the beaches and in the ships, and his criticisms on the conduct of operations are so bitter and prejudiced that, when so much other material on the campaign exists, it is better to leave these unread. The book is illustrated with some good photographs, but there is no Index and few maps.

H.B.-W.

MAGAZINES.

BULLETIN BELGE DES SCIENCES MILITAIRES.

(1928. TOME I.—NOS. 1 TO 3 INCLUSIVE.)

Les opérations de l'Armée belge. The account of the Battle of the Yser is continued in these three numbers. The events of October 26th, 1914, are dealt with in No. 1 ; on this date the French troops, consisting of the 42nd Territorial Division, the Marine Fusilier Brigade, two territorial and two colonial infantry battalions, some batteries of heavy artillery, and three cavalry regiments, were placed under the command of General Grossetti, who was directed to hold the section of the front between Nieuport and Dixmude at all costs. The Belgian Army was now on the line of the Nieuport-Dixmude railway, and was supported on this section of the front by the French 83rd Infantry Brigade, and the French troops under Admiral Ronarc'h. The situation on the Belgian front was very disquieting on this day ; both the 1st and the 2nd Divisions fell back, and at one time the defence of the Nieuport-Dixmude railway line seemed to be compromised. In consequence, the Belgian High Command had to contemplate the possibility of a further retreat of the Belgian Army, and issued, therefore, instructions indicating the routes by which the several divisions should retire. Fortunately, the French reinforcements, which had been hurried to Belgium, helped to save the situation.

Brief references are made to the operations of the B.E.F. and the French troops which held the section of the Entente front southward of Dixmude. The French IX Corps was on the immediate right of the Belgian Army, its right flank rested at a point S.W. of Passchendaele. A mixed force from this Corps launched an attack against Poelcapelle on the 26th, but was soon brought to a standstill by the enemy, who was strongly entrenched. On other parts of its front this Corps was able to make an advance of some 300 to 400 metres. It had been intended that the B.E.F. should continue an offensive movement in conjunction with the French. However, the British plans had to be altered ; the enemy launched an attack, early on the 26th, against Kruiseeck, then held by the 7th Division, which had to fall back.

The events of the 27th are described in No. 2. On this day, quiet reigned on the section of the front S. of Dixmude ; an offensive was launched by the French ; they suffered heavy losses, and were unable to gain ground. Arrangements which the Belgian High Command intended to make for the purpose of carrying out the reorganization of the Belgian 3rd and 6th Divisions had to be temporarily abandoned, as it was found impossible to draw them out of the line.

The events of the 28th are dealt with in No. 3. It was now recognized at the Belgian G.Q.G. that the period of trench-warfare had set in ; instructions were accordingly issued for the routine which should be

adopted for meeting the new situation—these are set out in full in this number.

Brief references are made to the Belgian inundation scheme in all three numbers.

L'effort belge au lac Tanganika pendant la guerre, 1914–1918. The concluding part of the article under this title by Captain Weber is contained in No. 1; he deals therein with the operations of the Air Force sent to the Congo State; the activities of the naval flotilla on the Lake; the telegraph service provided for military purposes; the organization of the transport service on the Lake; and the restoration of the permanent way of the Kigoma-Tabora railway, and the resumption of traffic thereon.

Le Manœuvre en retraite. An article under this title appears in No. 1; it is contributed by Capt.-Comdt. Dujardin, who compares therein the tactical manœuvre referred to as the "hinhaltendes Gefecht" in Art. 13 of the German official manual entitled *Führung und Gefecht der verbündeten Waffen* with the "manœuvre en retraite" to which special chapters are devoted in the Belgian *Instruction sur l'emploi tactique des grandes unités* and the similar French manual.

Les Chars de combat. Parts 2 and 3 of this article, by Major Liévin, appear respectively in Nos. 1 and 2 of the *Bulletin.* Part 2 is devoted to matters connected with the speed, the design of the motor carriage, and the radius of action of tanks, whilst in Part 3 the problems which are dealt with are those relating to the passage over ditches and trenches by tanks, their ramming power and their climbing capacity. Both parts are illustrated by photographic reproductions and diagrams.

Le contrôle des clauses militaire du Traité de Versailles. This article, which is published in No. 1, consists of extracts from an account by M. Paul Roques, a former member of the Military Commission, of the work of the Inter-allied Military Commission of Control in Germany during the period September, 1919–January, 1927. On the withdrawal of the Military Commission in question, its work was transferred to the League of Nations, which has formulated rules for the guidance of the Commissions of Investigation which it may appoint; these rules are set out in the original article.

Napoléon Ier—Sa vie et son œuvre. The first part of an interesting article under this title by Major F. Delvaux appears in No. 2.

L'organisation militaire de la Russie. This article is published in No. 2; it contains an important summary of the Soviet Law relating to compulsory military service, which came into force in Russia on October 1st, 1925. Particulars are given of the Headquarters organization; the General Staff; the general principles on which compulsory service is enforced; the mobilization plans; and the composition of the army under peace conditions.

Du rôle de l'Armée de campagne et des fortresses belges en 1914. The first part of an article, contributed jointly by Lieut.-Colonel Duvivier and Capt.-Comdt. Herbiet, both of the Belgian General Staff, is published in No. 3. It consists of an introductory statement, in which the authors point out that at a meeting of the "Societé des officiers de Berne," held on January 26th, 1927, Col. Jenny, of the Swiss Army, delivered a

lecture entitled " Die Festungen im Weltkrieg "—published in the *Bund* (of Berne) dated January 29th/30th, 1927, No. 45—and therein made certain disparaging remarks concerning the Belgian troops engaged in the defence of Liège and of Antwerp. The authors of the original article state that they are in agreement generally with the views of Col. Jenny on the subject of the value of permanent fortifications in a future war, but they challenge his allegations in regard to the conduct of the Belgian troops; the purpose of their article is mainly to refute what they consider to be the erroneous views contained in the Berne lecture.

Les nécessités de l'organisation militaire du temps de paix. This article, which appears in No. 3, is based on the new French laws relating to military service, and is an important contribution on the subject; some of the principal features of these laws are analysed therein. Further, extracts are given of the views expressed by members of the various political parties in France, on the subject of providing for the French Army, even in normal times of peace, a permanently organized covering force on the frontiers.

Délibérations de la Commission. King Albert has authorized the appointment of a " Mixed Commission," (*a*) to make an examination into the present organization of the Belgian Army, and the defence requirements of the country, and (*b*) to put forward recommendations on these two matters, should any reorganization be deemed necessary. The Commission met for the first time on December 29th, 1927, and was addressed by the Minister for National Defence and the Chief of the Belgian General Staff; the speeches made by them on that occasion are reported, *in extenso*, in No. 3 of the *Bulletin*, and provide an interesting account of the Belgian military situation at that date.

L'organisation militaire de l'Allemagne. The original article appears in No. 3, and in it a short biographical notice relating to Gen. Groener, the New War Minister, serves as an introduction to the details given concerning the present day German Army. Although the peace establishment of the German Army is strictly limited by the Treaty of Versailles, and must not exceed 100,000 altogether, it is pointed out that, at short notice, the whole nation could be mobilized for active service, fully equipped in the most up-to-date manner. Details are given of the skeleton organization of the German Army, and of the methods adopted for training the officers, N.C.O.s and men, and also of the steps taken to provide a preliminary training for the youth of the nation so as to prepare them for military service in case of need.

W.A.J.O'M.

THE MILITARY ENGINEER.

MAY–JUNE, 1928.

An article on *Aerial Surveys in South-Eastern Alaska* gives a description of the organization, equipment, and experiences of the Alaska Aerial Survey Expedition. The utility of this method of survey is well established, where the nature of the country is such that land parties would find great difficulty in working. The expedition was based on an

airplane tender, and the members of the expedition lived on a converted ammunition barge, 140 ft. by 40 ft., which was towed by the tender. Four Loening Amphibian planes were used, one of which, however, crashed on the way up. The mapping camera was the Bagley tri-lens camera, a description of which is given. The methods followed and the general conditions under which the work was carried out are fully described.

The Binaural Aircraft Detector. This article describes the principles of the sound locator for anti-aircraft defence, as used in the U.S. Army. " Sound is a vibratory disturbance in the atmosphere, or other medium, wherein a pressure wave is set up, travelling from the sound source in all directions at the rate of 1,100 feet per second. This sound wave arrives at a listener's head, and unless he is looking in the direction of emission, it will impinge upon the diaphragm of one ear a fraction of a second sooner than upon that of the other ear. The resulting sensations, transmitted to the brain, are there analysed by point of time, with the result that instinct tells the listener that the sound source is at a certain angle to the right or left. If, now, the listener turns his head the proper amount, the sound wave strikes both ears simultaneously, and is analysed as coming from the front. This ability of the ears and brain to determine direction acoustically is called the binaural sense ; the effect of the sound wave on the ears is called the binaural phase effect." By using exponential horns, separated more widely than are the human ears, greater efficiency is obtained. A photo is given of the apparatus used. Four horns are mounted so as to have their axes always parallel. One pair is used for azimuth determination, and one for elevation. There is an operator to each pair of horns, who controls the horns by large hand-wheels. Other numbers read off the scale-indicators. Atmospheric corrections are applied to the readings, and the direction angles are then automatically transmitted to gun batteries, or searchlights. These automatic data transmitters are one of the latest and most important additions to the equipment, and are essential for accurate work with a quick-moving target like an aeroplane. It is possible now to set the guns automatically. As the sound locator has a range of from 10 to 15 miles, while the light has a range of from 6 to 7 miles, there is ample time for the listeners to get the plane's course, and set the light before the plane comes within range of the light, which is kept obscured till required. It takes approximately 30 seconds for the guns to commence firing after the first observation with the light.

An article on *Pre-cast Concrete Military Roads* discusses the possibilities of constructing such roads on service in the base areas, where traffic conditions make it desirable, the idea being to get a durable wearing surface in the quickest time, and with the least dislocation of traffic.

Some Observations of an Instructor, based on notes made by the author during five years' work as an instructor at the U.S. Military Academy, and on R.O.T.C. duty. The best methods of catching and keeping the students' interest and attention are discussed, and a lot of practical advice is given. There are two discussions of the article. The first contains the following : " Of the various methods of instructing discussed the least permanent good will be accomplished by means of lectures . . .

A good example of an optimist is an instructor who believes that his class of well-fed students, apparently listening to a talk in a quiet room, after a busy day in the office or the field, will retain anything of what the speaker is saying." In the second, emphasis is laid upon the personality of the instructor as being the main factor in successful instruction.

In an editorial, the difference in practice in civil and military engineering is discussed, and the erection of a bridge is taken as an example. The following Table gives the differences.

	Civil.	*Military.*
Ultimate aim	... Convenience of man.	Defeat of the enemy.
Economy ...	... Cost primary, time secondary.	Time primary.
Factor of safety	... Ample margin.	Barely sufficient.
Site	... Carefully selected.	Dictated by military necessity.
Durability ...	... Permanent.	Temporary.
Material ...	... Suitability controls.	Availability governs.
Construction machinery	... Highly specialized.	Simplest mechanical devices.
Transportation	... Economically sufficient.	Generally, insufficient, often only man-power.
Labour ...	... Selected specialists.	Versatile and adaptable.
Operating conditions ...	... Normal.	Frequently under fire.
Preliminary investigation	... Deliberate.	Hasty, if any.
Beauty ...	... Aesthetic rules.	Not even considered.

In *The Importance of War Principles* Colonel Jackson considers the question from the point of view of the training of the Reserve officer, to assist him in adapting his civil engineering knowledge to war conditions. He cites four outstanding basic principles: conservation of time, simplicity, organization, economy of personnel and material, and illustrates their application from his own personal experiences, which he considers as those of the average officer. "What I offer below will be aimed at showing what a small factor detailed knowledge plays in war, and what a large factor knowledge of basic principles plays: particularly those principles relating to organizing and economy of materials." The whole article is sound and instructive, and a few quotations may be given. "Before the War, I had learned something about two important assistants, so valuable to all leaders, the desk and the waste-paper basket. I had learned that the desk has two main uses: an object used as a sort of a work-bench, and an object upon which to repose one's lower extremities. I had learnt that it can be used properly for both efforts, but that, if a leader must concentrate on one, it is better to concentrate on the second use." One hundred or more men sent in applications for transfers to other work. As the applications, which were for personal reasons and not in the interests of the Service, had not died in the company

offices, they properly met their end in the author's waste-paper basket, which illustrates all four basic principles.

" As every living thing has its deadly parasites, so has the individual's activity. One of these is details. Succumbing to the temptation to handle details has probably destroyed more leaders in war than bullets or disease."

The test to be applied to all war construction is, " Is this necessary ? " and " Will less suffice ? "

The remaining articles deal with civil engineering works, and with the training of the Engineers of the Reserve, and National Guard.

P.H.K.

BILDMESSUNG UND LUFTBILDWESEN.

NOS. 1 AND 2 FOR 1928.

Neues Verfahren zur Landesvermessung mittels Luftbilder., by I. Boer. A method, involving certain new features, is indicated for determining the tilt of aeroplane photographs by observation on the aeroplane in flight at the moment of exposure. Various ground stations, whose surveyed positions need not be known, are sited outside the area to be photographed, and are equipped with a special heliograph, or some form of searchlight, provided with a vertical circle. The beam of light emitted from this instrument is kept trained on the aeroplane in flight, and the angle of elevation of the latter at each exposure is measured. In the aeroplane, the projected beams of light are reflected on to a photographic plate of an auxiliary camera rigidly attached to the main camera by means of a mirror system fixed to the camera. In the result, a photograph is obtained which contains several images, whose nadir distances are known by direct measurement. Two such nadir distances are sufficient in theory to locate the plumb point of the photograph. In practice, at least three would be required in order to include a check.

The determination of tilt is carried out instrumentally in a special machine known as a " deklivometer," consisting mainly of the actual auxiliary camera used in the air, together with its mirror system. The photographic images of the points, whose nadir distances are known, are reprojected through this camera, and received on appropriate screens. The latter are engraved with a family of hyperbolæ, each of which is drawn out in conformity with the dimensions of the apparatus to correspond to a definite nadir distance. The negative is then *translated* in the focal plane of the camera until each screen image falls on the hyperbola corresponding to its known nadir distance, when it is claimed that the plumb point will be located on the axis of the camera. This adjustment is presumably effected by trial and error. The auxiliary camera used in the air must of course be focussed for infinity, so that, in order to preserve focus on the screens during reprojection in the " deklivometer," it is necessary to add auxiliary lenses. The author suggests that these should be placed *fore and aft* of the camera objective.

The design of the " deklivometer " invites criticism. To begin with, the proposed system of translating the negative in the focal plane is at

variance with the most elementary rules of photographic perspective, and, even supposing that the points could be made to project in this manner at their correct nadir distances, would certainly not afford a true measure of tilt. The use of auxiliary focussing lenses, a *common* resort in such cases, is also very apt to upset either the internal or external perspective. In this case it would upset both. Failing a suitable design, the "deklivometer" could, however, be replaced by a matter of fifteen minutes' simple computation, without prejudice to the practicability of the method as a whole.

A practical point, demanding serious consideration, is the number of ground stations which would be required. In order to deflect the beam of light emerging from these ground stations into the auxiliary camera, the theoretically ideal reflecting system would be a truncated cone, polished on its exterior surface. The author rightly decides that this would not reflect sufficient light to affect the photographic plate, and he accordingly reverts to a system of plane mirrors, and thereby embarks on a sea of troubles. Whatever the arrangement of these mirrors, their fields are bound either to overlap or else not cover an all-round view. If they overlap, then some of the images may be duplicated, and there will be difficulty in deciding which nadir distance belongs to which. If, on the other hand, the number and arrangement of mirrors is so restricted that there is no overlap, then one or more of the projected beams may be missed, so that a factor of safety has to be applied to the minimum number of three ground stations. In order that the reflected beams may be received on the photographic plate, moreover, some restriction must be applied to the range in tilt of the photograph and to the permissible nadir distance, that is, to the angle of elevation of the heliograph. This, in turn, limits the height of the aeroplane, and the distance of the heliographs, with a further effect on the number of ground stations required to be established before undertaking photography of a specified area. If the further conditions of possible clouds obscuring one of the stations, accidents and, above all, the human element, are taken into consideration, it is very doubtful whether the proposed number of five stations for an area of about 35 square miles would be anything like sufficient.

Air photography is very much subject to weather conditions, and it is an alarming outlook to consider the economic results of maintaining all these ground stations while awaiting a suitable opportunity to expose the photographs.

Direct observations on an aeroplane in flight have been tried before for survey purposes, and have never met with any considerable measure of success. It is true, however, that the observations in this case are confined to a measurement of vertical angle only, and that the aeroplane would not appear to move rapidly in altitude under the conditions necessary for the operation of this system. Nevertheless, it would be no mean achievement to control a large number of scattered operators to observe simultaneously at about 30 seconds' interval on a rapidly moving machine, and at the same time to keep the reflected beams from the sun directed on the aeroplane.

The office work entailed in sorting and indexing the photographs of a large area is in any case considerable. The proposed system would add

an equal number of auxiliary photographs and a mass of independent ground observations, all of which would have to be sorted on a time basis and related to their appropriate photographs.

The author considers that an accuracy of ½° on tilt determination would be sufficient, but he entirely ignores the question of heights. For instrumental contouring, something like two or three minutes would be nearer the mark, and it is unlikely that this degree of accuracy would be obtained by the methods proposed.

M.H.

HEERESTECHNIK.

JULY, 1927 (*continued*).

The French Regulations for the Training and Employment of Engineers, 1926 (*continued*). The German reviewer awards special praise to the trouble taken by the French in training their officers of the Reserve outside the time when they are called up for manœuvres. The education of these officers is carried on in the Associations of Reserve Officers, and by means of the Reserve Officers' newspapers, and is so efficiently performed that he can only confirm the fact "in sorrow and care." France has thus at her disposal a powerful reserve of leaders, which allows it to the widest extent to post active officers to 2nd line field units, while Germany, he complains, "has not even enough for the most urgent peace-time needs."

The next point which he finds better done in France is the provision of staff for looking after Engineer stores. For a regiment (3 bns.) of Engineers there are, for mobilization and peace technical equipment only, (*i.e.* not for clothing or rations), a staff officer as chief, with a staff captain as assistant, and one subaltern for each battalion, also one or two administrative and accountant officers and a staff of military and civilian tradesmen and labourers. Besides these, who are exclusively concerned with Engineer stores, there are others who combine them with other duties, *viz.*, the Lieut.-Colonel on the H.Q. staff of the regiment and a not inconsiderable staff at regimental H.Q. Compared with the total of eleven officers permitted to a German Engineer battalion, this is a lavish expenditure of officers.

A drawback of the specialization of Engineers in a short-service army is the large amount of writing and records that it entails. Before the mobilized man can be brought to the spot for which he is best trained and fitted, so vast a number of personal documents, employment sheets, rolls and registers has to be kept up, that it is not surprising to find the French regimental units complaining of having too many men on command: the Training Manuals admit resignedly that hardly a man with more than twelve months' service is to be found in the ranks. The French writing-rage or papermania, telling its tale of little faith in subordinates, appears to Germans both "foreign and unmilitary." The author has no good word to say of the system of overstrained control over lost and expended stores, which incites to dishonesty, or of the meticulous care in accounting which spends more money on a missing

article than the article is worth. He finds fault with regulations which inculcate independence and initiative and then so bind men that they have no field in which to exercise them. Also with regulations which talk continually of responsibility, but nowhere of the glad acceptance of responsibility, much less of education to that end. "War is not a matter which can be governed by hard-and-fast rules: it is a system of expedients. Expedients can only be found by leaders trained to find a pleasure in accepting responsibility." These pronouncements lead him back from the French regulations to the concluding dictum of the German Training Manuals:—"Inaction and delay are more damaging to the soldier, highest as well as lowest, than a mistake in the choice of means." —(*To be continued.*)

(*August*, 1927).—*The Materials Session of the Union of German Engineers.* The ever-increasing performance demanded of guns, vehicles, etc., makes an ever-increasing demand upon the quality of materials. To no branch of technics, therefore, is this Session of greater importance than to the Army. Its objects are announced as being:—

(1) To spread the knowledge of materials and of their best employment among the broadest circles of the German people.
(2) In all circles engaged in handicraft or trade to gain fellow-workers in the effort to improve the standard of industrial products.
(3) To bring together all classes of producers of materials with all classes of users of materials, for co-operation to promote technical progress.

The International Motor-lorry Exhibition at Cologne, 20th–31st May. Dr. Stadie concludes his description with a number of good photographs and a tabular analysis of the lorries exhibited, giving percentages of all varieties, from 4-cylinder 79, 6-cylinder 21; cylinders *en bloc* 82, cylinders in pairs, 18; 4-wheel brakes 48%; multiple-plate clutches 42%; forced-feed lubrication 85%, down to the percentage of drivers' seats right and left. He laments that the Germans are so slow in adopting the worm-driven rear axle, which has long made good in England. The Hansa-Lloyd are, however, pioneers in this respect. The illustrations are:—

Section of Servo-brake, as made by Bosche-Dewandre (owing to cheapness and lightness now rapidly replacing compressed-air brakes).
Photographs of the Faudi system of air-springing as applied to an omnibus.
Plates and photograph of Mannesmann-Mulag lorry, 6-cylinder engine and gears, chassis, front axle (new construction).
Framework of Henschel lorry on locomotive lines, consisting of only two parts, *viz.*, seven similar cross-pieces and two longitudinal pieces.
New air-cooled Phenomen-Engine Type 4RL.
Czecho-Slovakian Tatra car, which has a tube instead of a frame.
Photograph of Büssing two-storey omnibus with air-tyres and three axles, to take 81 passengers.
Vomag-chassis for a low omnibus with 6-cylinder engine and steel framework for superstructure.
N.A.G. and Apollo 50 H.P. tractors.

The exhibits from foreign countries, Ford, Studebaker, G.M.C. Citroën and Bernard Lancia, Minerva, Austro-Fiat and Steyr were disappointing and are dismissed in a few words.

The Instruments of the A.A. Artilleryman (*continued*). Specimens of shooting-tables are given for " Target coming " and " Target going " and worked out for a fixed height of target and four different angles of travel from 0° to 90°, *i.e.*, from directly approaching the gun (or going away from it) to crossing it. Each line of the tables gives the directions to the gun-layer corresponding to the foregoing conditions and to the range-finder distance (within 200 metres). An example is then given, and, after having called the tables the keystone of all the anti-aircraft instruments which must never be missing at any gun, the article concludes with calling senseless and absurd the method of taking " pot-shots."

Report of the Government Survey Office for 1925/26. This year again there have been insufficient personnel and insufficient funds to carry out the necessary work. The report manages to avoid gloom only by keeping to the facts and making no deductions therefrom. A slight increase in the grant for fieldwork did not permit of the upkeep of trig. points, the correction of levelling, the putting in hand of topographic new measurements, or the keeping up-to-date of mapwork through local investigation. During the year 400 lost trig. points have been restored, against 127 last year, but also against a total loss of trig. points estimated at 10,000 ! This can hardly be called making headway.

Of 130 survey-sheets in East Prussia, etc., which require to be done again, only 8 could be revised. Changes of railways and roads could be entered up in only 296 sheets instead of 600 according to the programme.

In spite of these failures there is progress to record. The Government has sanctioned the agreement with the Aero-Lloyd Airphotograph Coy. for co-operation in the preparation of the 1 : 5,000 map.

An air-photograph of the State forests at Grimnitz has been prepared, 40 sq. miles at 1 : 5,000, and the photographs have been taken for a similar piece of work for 120 miles along the Oder.

The territory of the town of Goldberg which was taken last year by stereophotographs and plotted on a scale of 1 : 5,000 by the Stereo-autograph was completed topographically in four months by the middle of September.

Photographs from the air are also necessary for the survey of a catch-ment area required by the Water-suppply authorities at Stettin.

The French Regulations for the Training and Employment of Engineers, 1926 (*continued*). This month's instalment deals in detail with the duties and training of the following branches:—Sappers and Miners, Cavalry Divisional Engineers, Electro-Mechanicians, Pontoneers, Heavy Bridgers, Inland Waterway Companies, Signal Service and Railway Engineers.

The reviewer makes no comparisons with German methods or with German ideas, and no comment beyond his little joke that it is for the defence of France that the whole training of the Inland Waterway Service is directed towards a crossing of the Rhine.

France and the Question of Substitutes for Petrol. At Montpellier, from

the 15th to the 17th June, was held a congress on petrol substitutes, in which took part representatives of several Government departments of science and of the coal, alcohol and motor industries. This congress showed how much importance the leading classes in France attribute to the motive-spirit question, and how strong are the forces at work in politics, research and economics to solve this question. From the Great War the lesson had been learnt that motive-spirit belongs to the requirements of the first order with weapons and ammunition. And indeed this will be the case in increasing measure the more that war motorizes and the more that superiority in aeroplanes, tanks and in the massing by surprise of men and materials at spots, which can only be served from great distances, become the indispensable preliminaries of victory.

It has also been recognized that France in a new warlike entanglement must reckon upon not having England and America as allies and sources of supply: while on the economic side the French, being still in their period of inflation, naturally seek to restrict imports and thus check the flow of gold abroad. Petrol was imported into France last year to the value of 400 million gold francs.

The following are the models by which the Congress seeks to achieve independence of foreign petrol:—

(1) Increasing home production from the oil wells of Pechelbronn in Alsace and of Gabian in the south of France.
(2) Increasing the number of coke ovens at which petrol is a by-product.
(3) Increasing under the law of 1923 the number of gasworks owned by Corporations, at which petrol is a by-product.
(4) Increasing the production of alcohol out of sulphite process waste liquor and out of wine-making residues.
(5) Using solid or gaseous fuel instead of liquid.
(6) Producing synthetic motor-spirit.

As regards (1) to (3) certain limits are imposed by the size of the oil-fields and by the possibility of disposing of the masses of coke obtained. As regards (4) and (5) quite extraordinary exertions have been made, which indeed may have already passed the bounds of economics and of reason. Thus, after thorough investigation by the Research Institute for Power-Spirits at Montpellier University, in spite of the enormous expense and slight result, it has been proposed in all seriousness to construct stills at hundreds of large wine-presses in order to increase the 20,000 tons of technical spirit at present produced per year to 100,000 tons. If this project founders, as it assuredly will, on the high cost of this method of obtaining alcohol, there is another method of doing without alcohol which deserves great attention, viz., the equipping of lorries with wood-coal-driven gas-engines, which is being heavily promoted by means of remittance of taxes and of direct subsidies. Already hundreds of lorries and cars are so equipped, and the ideal aimed at is for lorries, at any rate, to make this drive universal. As regards (6), the greatest and most promising efforts are being made in getting artificial motive-spirit out of the coke-oven gases, and also in the liquefaction of coal. For the time being, it appears as if the most significant achievements were in the

synthesis of Ethyl Alcohol at the mines in Béthune, and of Methyl Alcohol at Kuhlmann's Works. At Béthune a large-scale trial is working which yields 4 tons of Ethyl Alcohol a day, while Kuhlmann's will shortly be producing Methyl Alcohol on a much larger scale.

Meanwhile, France does not neglect foreign oil-sources, as evidenced by her interests in Poland and Rumania, and by the allocation of 25% of the Mesopotamian yield, granted by the Standard, Royal Dutch and Anglo-Persian Oil Companies.

The author is tempted to wish that Germany, to which the question of independence in petrol supply is of even greater importance than it is to France, would take a leaf out of France's book.

(*September*, 1927).—*Light Metals and their Use as Construction Material.* This article was written in connection with the then forthcoming Materials Exhibition of the Union of German Engineers, in order to emphasize the importance of the light metals, aluminium and magnesium and their alloys, to German industry and economics. A century ago, Wöhler, by obtaining a typically organic compound, urea, from its isomer, ammonium cyanate, broke down the barrier between the inorganic and organic worlds, and cleared the way for synthetic chemistry. It was in the same year, 1828, that he discovered aluminium. Thirty years later, the price of aluminium was still as high as £6 13s. 4d. per lb, but increasing production brought it by 1912 to its low-water mark of less than ninepence per lb. Pure aluminium, whether cast or wrought, has low tensile strength, and so is of little importance to the machine-constructor. Its alloys, however, with copper, or with copper and zinc, or other metals, have such greatly improved mechanical properties as to resemble steel. The oldest and best known of these is duralumin, originally consisting of aluminium and magnesium only, but now including copper and manganese. The greatest consumers of duralumin are the automobile industry, and the builders of airships and aeroplanes.

An alloy of great importance is lautal (Al., 94%, Copper, 4%, and Silicon 2%). It can be cast, does not solder, can be sweated, but cold riveting is preferable. It is particularly recommended for its resistance to the weather and to sea-water. The three 17-metres high rotors of the rotorship *Barbara* were made of lautal by the Lautal Works in Bonn.

An alloy specially suitable for castings is silumin (Al., 87% : Si., 13%). In addition to being used for lorry, omnibus, and aeroplane wheels, it is used for telescopes, photographic apparatus and parts of typewriters.

Two other alloys, scleron and aeron, emanate from the same firm as silumin, viz., the Metallurgical Society, Frankfort-on-Main. Of these two, scleron is remarkable for high tensile strength, and aeron for great flexibility, the latter being suitable to replace soft brass sheet.

One of the most recent aluminium alloys is constructal, which contains zinc and magnesium. It has the highest tensile strength of all. The best resister of corrosion is called "K. S. Seewasser," and consists of Al., 94%, Mn., 3%, Mg., 2½%, Sb., ½%. It is said to cast easily and to forge and roll well.

All these aluminium alloys have a powerful competitor in a magnesium alloy known as elektron, and first put on the market at the International Aviation Exhibition in 1909. It is below both duralumin and lautal in

tensile strength, but is distinguished by being specially easily worked, and by its low specific gravity of 1·8, while the aluminium alloys run from 2·65 to 3. Elektron is extensively used in the motor-industry for pistons.

The chief disadvantage of the light metals at present is their high price. This will certainly come down as they are increasingly used. They will probably be first called upon to replace copper, lead and tin. Even steel, on account of its great weight, has been forced in some cases to leave the field to these dangerous competitors, and it is, perhaps, not too bold to foretell the coming of a light-metal age.

The Methods most in use for Testing Materials. Written, like the foregoing article, as an introduction to the Exhibition of Materials. I gives a short description of the various static tests, in which pressure is gradually applied, *viz.*, tests for tensile strength, crushing, bending, buckling, shearing, perforation, and twisting. Also of dynamic tests in which a sudden blow is given, *viz.*, tests for tearing, crushing, bending, brittleness and durability. In order to gauge results in the dynamic tests, the energy expended has to be worked out, instead of simply measuring the force applied as in the static tests. Further tests to be seen are the tests for hardness, either by bullet-pressure (Brinell's) or by Shore's scleroscope; also Marten's scratching-test. There are also technological tests for toughness, plasticity, and workability, tests at red-heat, feathering test for rivets, and piercing tests. Purely physical tests are omitted, while chemical and metallographical tests which are amongst the most necessary equipment of the modern tester of materials, also find no place in the Exhibition.

The Equipment of the A.A. Artilleryman (continued). Major Sandkamp's short instalment deals with special equipment, plans of defence, arrangements for co-operation with other A.A. units, night-shooting and barrages. (*To be concluded.*)

The Yearly Report of the National Survey Office, 1925–26. This is a catalogue of the year's work, couched in such a form that it is not easy to see whether the Department is keeping abreast of its many tasks or not. As regards new work, eight sheets of the 1 in 25,000 map were prepared, and seven sheets of the 1 in 5,000, of which the latter has to be paid for in full by the parties concerned. As regards keeping sheets up-to-date, the addition of new railways, new roads, and other alterations, could only be started in one-third of the total area, and owing to numerous changes, lack of personnel, and lack of funds, could be completed in only a portion of that third. Complaint is made that the decision of the authorities to introduce the Gauss-Krüger system of co-ordinates caused a heavy burden, owing to checking and adjusting maps drawn on other principles. On the other hand, nearly one-and-a-third million maps were sold, and the turnover advanced 40% on that of the preceding year, to close on £70,000. So that there appear to be healthy features about the year's work, although no mention is made of the trig. points, whether the lost ones are being replaced, and the existing ones maintained. There is also no mention of aerial surveys.

The French Regulations for the Training and Use of Engineers (continued). The German reviewer starts this month by pointing out how clear is the fundamental difference between the French and German

training-manuals. Not only does France, under no restraint and in an advanced state of militarism, invade civil life and take tradesmen in large numbers, so that she is able to a great extent to specialize her military engineer service, whilst Germany, fettered by the Versailles Treaty, has to drag out of a minimum of personnel a maximum of performance of all sorts, but the whole French regulations breathe a spirit of shepherding and restriction which is foreign to the scanty pages in which the corresponding German training-principles are laid down. "It appears to me that the complaint so often raised in the French Press against bureaucratism and lack of initiative and readiness in accepting responsibility is justified by the systematization and the spirit of tutelage which these Regulations disclose. Apparently the fear of prominent persons and of their freedom of action is so great in the land of Liberty, Equality and Brotherhood, that even in military manuals every effort is made to prevent the education and the growth of personalities, to equalize human beings, and to systematize them. It may be that the French national character demands such narrow bonds, in order to keep the solid ground under their feet, and not to lose themselves in fantasy. For German circumstances the freer path to the responsibility of leaders inculcated in the German principles of training seems more suitable."

The reviewer then analyses Part I, Vol. 2, of the "Règlement sur la manœuvre et l'emploi du génie," but without comment. (*To be continued.*)

Special Cars for the Sahara. This article, dealing with a type of car capable of driving through sand, is one of a number provoked by the appearance of the article, "Motor Vehicles in Snow," recently reviewed. Other articles, which go to show that a large number of car-builders of all countries are busily engaged with these problems, have appeared in the *Automobil-Rundschau*. At the International Automobile Exhibition at St. Petersburg in 1910, the Russian military authorities caused a sensation by showing a car with a rubber-band drive. The inventor, Kégresse, was the superintendent of the Imperial Russian Automobile Park. The experts were all against the innovation, finding it of no practical importance. Kégresse, however, was not deterred by adverse comment, went on improving his invention, and in 1920 joined forces with the French car-manufacturer, Citroën. The French military authorities gave the invention a thorough try-out in 1921–22, and proved its value over loose soil and snow. At the end of 1922, five Citroën-Kégresse cars, starting from Touggourt, crossed the Sahara from Insalah to the Niger, and arrived at Timbuctoo, after having done 3,220 km. in 22 days.

Similar cars are now in regular manufacture.

The article then gives full details of the Kégresse caterpillar, with a lettered photograph. Other photographs show three of the cars crossing the Sahara, and the small 6-h.p. Citroën-Kégresse dragon negotiating a slope in a snow-covered landscape.

A Parallel between 1870 and 1914. In reviewing General Litzmann's Memoirs, Lt.-Gen. Schwarte points out a parallel "of quite special interest," between the two wars. "No one, who does not shut his eyes to the truth, will deny that, before the Great War, there was little understanding of the necessity for complete technical equipment in the army. It is

nowadays almost incredible that, in spite of the most valuable technical productions of German manufactories, the equipment of the Army in 1914 with telegraphs and telephones was so incomplete that communication broke down between G.H.Q. and the right wing, so that the latter's movements could not be controlled—one of the reasons for the result of the Battle of the Marne." An "almost grotesque prototype to this fateful lack of technical equipment" can be found in General Litzmann's description of the telegraph communication, which he, as a subaltern in 1870, had to establish between Divisional H.Q. and the outposts, which had been pushed forward nearly to the forts outside Paris. The Division had no telegraph material at all, and the procuring of such was left to the young Fusilier officer, who had never built a telegraph-line before, not even in peace. With requisitioned material and horse-sense he managed to get the necessary 6 km. of line built, but it took 1½ days!

Characteristic pictures of the position of military technics at that time are also given by the descriptions of the blocking of the Seine and of the blowing-up of a bridge under fire, both with the most primitive means.

(*October*, 1927.) *The Materials Exhibition, Berlin*, 1927. Articles on materials and upon material-testing having served as an introduction, this article is confined to the Exhibition itself, the nature and distribution of the exhibits. There are three main classes: (*a*) Steel and iron, (*b*) Metals other than iron, (*c*) Electrical insulators. Both (*a*) and (*b*) are sub-divided into three main branches: (a) Technological department, (b) Mechanical department, (c) Department of chemistry, metallography and physics, and have, together with their corresponding branches, been placed for convenience of reference opposite to each other in the building.

An interesting feature is that firms have no stalls: all exhibits are shown anonymously, and it is left to an enquiry office to furnish information as to the source of an exhibit on demand.

A handbook of materials, produced as a ring book, contains on single sheets points about the most important materials, and their properties, and is intended for notes on the exhibits and processes, and on the lectures, of which a list of twenty-three is given, covering the ten days of the Exhibition. There is also a pamphlet, WT4, issued by the Werkstofftagung, Berlin, NW7, Ingenieurhaus.

Finally, the hope is expressed for the realization of the objects of the instigators, *viz.*, exchange of experience between producer and user, increase of knowledge on the part of constructor and mechanic, and increase of interest and understanding on the part of the general public.

Materials in Automobile Construction, by Dr. Stadie. The main demand nowadays is for lightness, combined with the greatest strength. The greatest possible lightness has a double advantage. The price follows the weight, as the Americans discovered. It is owing to their influence that weights have been reduced in Germany, and that prices have come down 25 per cent. The reduction of 100 kilos in weight means 400 to 600 marks off the price of the car. Reduced weight also causes a saving in petrol. These considerations have had a great effect on the materials used in automobile construction. If, on the one hand, financial and economic reasons call for the lightest of materials, on the other hand

technical reasons govern their composition. Safety lies in the choice of suitable materials. Whilst one formerly calculated the engine, the transfer of energy, the drive and all that has to do with motion, from a general mechanical point of view, and clearly chose and dimensioned the material from these requirements, it is now recognized that of far greater importance are the requirements resulting from the dynamics of the car. One attempts by material and construction to keep down all dangerous oscillations, and pays great attention to fatigue-phenomena, which play a great part in all high-speed machines, on which periodical sudden demands are made, and which occur in materials as a result of constantly occurring jolts and jars caused by the road-surface.

We are now at the commencement of a great development of the materials of which cars are built. Although the steels and steel alloys have generally satisfied the demands made upon them, the question resolves itself out of a series of compelling reasons, whether this will in future be the case. In Germany especially, there has been a great increase in the use of the light metals. Unfortunately, it is precisely the light metals which suffer fatigue under sudden loads. Their perfecting in this respect is, therefore, being worked at most intensively.

The author then runs through the chief light metal alloys and their properties, and concludes with a 4-page list of motor-parts, showing material (*genus* and *species*), method of preparation, and specification figures.

The Equipment of the A.A. Artilleryman (*concluded*). This final instalment contains two specimen barrage-tables for two guns in the same battery, showing how the rounds are "staggered." The efficiency of the barrage obviously depends upon the excellence of these Tables. The necessary caution is added that, owing to the large number of guns required and the vast expenditure of ammunition, barrages must be quite exceptional, being permissible only when aimed shooting by searchlight is impossible.

The future is sketched by the author thus: Science will help us more and more to overcome the difficulties of A.A. defence by making the A.A. artilleryman's instruments and equipment more complicated in construction, but simpler in use.

Mechanical Transport and War. The translation of an excellent article in the *Rivista Militare Italiana*, by Colonel Maltese.

The French Regulations for the Training and Use of Engineers (*concluded*). The German reviewer, after finding the Appendix dealing with ceremonial "mediæval," sums up Part I, Vol. 2, as follows:—The French train their Engineers as purely technical troops, as we did formerly with our railway troops. We Germans give our Engineers a more thorough infantry training, so as to bring them closer to the other arms, to give them a full understanding of the infantry's needs and of the modern battle, and because it is precisely the military engineer's *rôle* to carry out all technical work on the battle-field, while the civil engineer can do everything that is required behind. These differing points of view lead to entirely different ways of organizing the Engineers. In Germany they are totally incorporated in the divisions, even in peace, have no higher Engineer commanders, serve under the infantry leaders,

and take part in all exercises and manœuvres with the troops. In France the Engineers are shut off from the other arms in Engineer-units, under Engineer officers up to the highest ranks. "If the French are nevertheless able to look upon the deeds of their Engineers in the Great War with satisfaction, even where the latter fought in the front line, and taking every risk, this must be attributed to the tremendous pride of arms of the Engineers, who have always rejoiced in special respect both in the army and among the people. Here we must take care to avoid comparisons which might lead us to imitation."

Turning to Part II, this apparently has no German counterpart. It is called the *rôle et emploi du génie en campagne, i.e.*, F.S.Regs. (Engineers), and deals, the German reviewer considers, in verbose manner with things which in the German army go without saying. It is not known whether he includes in this category the following particular piece of wisdom :— "Engineers need, like the other arms, rest, training, and consideration. They will be relieved at the same time as the larger formations."

The composition, organization, and duties of Engineers in the field are then dealt with, and the duties of the higher Engineer officers. Of the latter, the reviewer thinks their position invidious, and that they must exercise much tact in order not to offend Formation Commanders, who often regard them as "troublesome spies." In order to obviate this, the Germans have turned their superior Engineer officers into Staff officers, pure and simple, so that the Formation Commander issues his own Engineer Orders upon the orders issued to him by the Engineer officer of the higher formation, just as he issues Operation Orders upon the orders he receives from the General Staff.

A word of praise is not omitted when the reviewer finds on comparison the French regulation clearer or better, as in the following instance, "To destroy incompletely in retreat any work, which it is hoped later to utilize, is to present to the enemy the facilities which one hopes for later for oneself. Moreover, one may rest assured that by that time the destruction will be complete." This is preferred to the German regulations, that "in retreat, railways and railway-bridges are to be blocked, but not destroyed without orders from the Supreme Command," since such orders will always arrive too late.

In general, the reviewer thinks that these Regulations can only serve to strengthen the setting apart of the French Engineers as a special arm, and to separate them further from the main arms. He ends with the compliment that the French Engineers were always found in war to be brave, tough, and self-sacrificing, and that their opponents will have to reckon with their being the same in future.

(*November*, 1927).—*Drawings of Army Equipment.* These drawings are necessary for the following purposes : Manufacture, assembly, issue, use, up-keep, administration, carrying out of changes, and also for instruction. Before reproduction in quantity for general issue, they pass through the following stages : designs, drawings for patterns, and working drawings. They did not formerly concern the troops to any great extent, but this is no longer the case, since not only has equipment become increasingly technical, but the troops have also been made responsible for carrying out certain changes of equipment in their own shops.

The rules here given, or similar ones, as regards preparation, classification, size, scales, numbering of sheets, etc., must form the basis of every good drawing-office. There are six standard sheets, lettered from A to F, and all sheets are divisible only in half, excepting the smallest, F. Omitting A (which is a special size and = 2 B), drawings of complete equipment are usually issued on standard sheet B (594 x 841 mm.). In size, B = C + D + E + 2 F, and F is 148 x 210 mm. F is for part drawings (whenever possible at 1/1), while C, D, E sizes are available for all necessary drawings intermediate between the complete equipment drawing and the drawing of a part, *viz.*, group, sub-group (*a*) and sub-group (*b*).

Two practical rules are given for the use of drawings issued to units :—

(1) The best use of an equipment drawing is not to keep it shut up in a drawer for reference only when required, but to hang it on the wall in an appropriate spot, where it will be not only an aid to private study, but a stimulus thereto.

(2) In order to encourage private study, care must be taken to change the drawing from time to time.

The article has an attractive historical Appendix, in the shape of eight sheets of equipment drawings, starting with a 150-year-old drawing of a powder-mill, and leading up to the modern cooker. The examples dating from Frederick William I., and the early nineteenth century, are the best evidence that the value of perfect drawings has long been appreciated.

The French Tank, Char 2 C (Char de Rupture). This tank was long kept secret. The present article follows upon the publication of a photograph and short description of it in a Polish military technical magazine. The *Char 2 C* was, however, both shown and described in Part 2 of Major Heigl's Supplementary Volume, 1927, to the " Taschenbuch der Tanks " (reviewed in *The R.E. Journal*). The following particulars are noteworthy : Total weight, 68½ tons ; maximum height, 13 ft. 4 in. ; length, 34 ft. ; crew, one officer and 12 men ; armament, one 75 mm. gun (in turret, arc 270°), four m.g's. (one in aft turret, arc 270°, one forward, and two in chambers built out at the sides). Each caterpillar is driven by a 250-h.p. six-cylinder engine with dynamo-motor combination, but can be driven by the other engine as well ; maximum speed, 6¾ m.p.h. ; for long marches, about 3 m.p.h. ; range, without refilling, 8 to 12 hours ; cost, £25,000. The tank is completely watertight to a height of 5 ft.

On reports as to the *Char 2 C's* ability to cross trenches, ascend steep slopes, travel over swampy ground, destroy all artificial obstacles, and as to its being armoured against field-guns, the French may well claim to have built the first real break-through tank. The German reviewer thinks that a handy fast tank like the Light Vickers could easily put it out of action from behind.

Effect of the Mechanization of the Army upon the Organization and Use of Divisional and Corps Engineers in the Field. Compiled from Major Dewing's article on the same subject in *The R.E. Journal.*

The French Camouflage Regulations (Provisional). That it took nearly nine years from the end of the War for this book to appear indicates the

difficulties which have attended the clearing up of the subject, both scientifically and practically. The book itself, consisting of only 79 short pages, is praised by its German reviewer in that it contains only principles which are common to all arms, and thus avoids the repetitions which are to be found in the American and Russian Camouflage Regulations. Many carefully-selected pictures, combined with clear explanations, make these Regulations eminently understandable. The sections are: Objects of Camouflage; Necessary preliminary knowledge; Natural and artificial means; Erection; Special apparatus; Organization; Training.

The special apparatus includes armoured O.P.s, hollow iron trees, watch-towers, the Bottin ladder (weight 190 lb., 70 ft. high, made in eight parts, fastened to trees by cramps), and the Bottin telescopic mast (erected by 4 men in 15 minutes, and then capable of extension with observer to 60 ft. in 1½ minutes).

Section 2 is considered the most valuable in the book. It gives in compressed form the results which have been most carefully worked out of the rich material collected in war, and in subsequent trials, with ground, balloon, and aeroplane observation, and from air-photos. As might be expected, the place of precedence is awarded to air-photos. Shadow-formation thus becomes more important than colour; and camouflage becomes less a question of the colour-scheme than of the space-effect, "not so much painting as sculpture." In the War the French, under the influence of the artists whom they had called in to assist, thought otherwise. Now on the evidence of the air-observer and of the air-photo they have changed their opinion.

Ten Years of the German Standards Commission. On the 28th October, the German Standards Commission celebrated its completion of ten years' work.

What this Commission is, what its aims are, and what it has hitherto accomplished, are things hardly known to the great majority of people, much less appreciated by them; and yet the work of the Commission influences very powerfully the whole work of the nation.

In this article the Commission's 10-year Jubilee is, therefore, seized as a good opportunity for reviewing the Commission's task, its growth, and its successes.

The striving through simplification of production to bring about at the same time both cheapening and improvement of products, is a road upon which all producing nations have been forced by competition. The leaders in this matter of productive standardization and in progress towards simplifying and nationalizing production are Germany and the United States. Germany in especial, by reason of the issue of the War, and of the enormous reparation payments imposed upon her, was forced to adopt standardizing, cost-reducing, economic methods of work.

Starting in certain distinct departments, like machinery, electrotechnics, army equipment, etc., standardization in Germany has continually increased its scope to embrace fresh fields—building, mining, automobiles, armaments, metal-ware, and many other things, like bicycles, boxes, stationery, ceramics, and porcelain.

Standardization has only been possible by overcoming great difficulties

—a certain inertia amongst producers, a certain inertia amongst buyers, the fear of prejudicial competition, even a certain dislike for " too many rules," and the fear that the buyer would not give up his special desires ; all these combined to set formidable obstacles in the way.

Then, however, gradually the recognition gained ground that standardization and quality were not opposed to each other, indeed, that they assisted one another ; that the advantages of standardization were common to all, producer, dealer, and user, so that the work of the Commission benefited every class.

The Standards Commissions of nine European nations sent to the celebrations representatives, who were entertained with lectures and an exhibition of standard articles of all sorts, from tools to type-writers, from paper-products to pottery. The President, Dr. Neuhaus, told them that the striving for usefulness, the striving for order and clearness, and the desire to separate the essential from the inessential, had been the chief carrying powers of the German work of standardization.

Mechanical Transport and War. The translation of Col. Maltese's article in the *Rivista Militare Italiana* and Transport, is dealt with as clearly and logically as were the Engine, the Vehicle, and the Motive-power. When, however, we come to Roads, the demands for good roads instead of bad ones, and for trees to be planted on both sides of them, point to Italy as the theatre of war in the writer's mind, and the article ceases to be of general interest.

A Home Observers' Corps for Anti-Aircraft Defence. Consists of notes from *Flight* upon an institution peculiar to England, viz., the Corps of Volunteer Observers, which from small beginnings, in 1924, now embraces the whole of Essex, Sussex, Hampshire and Kent in a network of observers' posts, connected by telephone, and is still in process of extension. The services of these volunteers are considered " vital " for home defence by the Government, and high appreciation of them was expressed by the Air Ministry after the five days' air-attack on London last September.

(*December*, 1927.)—*The Development of Mechanical Vehicles for General Load-carrying Purposes in the Army.* Since Germany, under the provisions of the Treaty of Versailles, has lost her former lead of the world in matters military, it is natural that German officers should feel themselves constrained to seek the best information of military progress in material and in ideas from other countries.

The case in point is a lecture before the Institution of Mechanical Engineers by Capt. C. H. Kuhne, D.S.O., O.B.E., R.A.S.C. (now Major, R.A.O.C.), with the above title, and, having special reference to the W.D. type rigid-frame six-wheeled lorry. This it deals with, after a historical introduction and a list of salient desiderata, under the headings : Suspension of the 6-wheeled lorry, W.D. principle of rear-suspension, transmission, tyre-equipment, new tyre developments, tyre-pressures, overall non-skid chain, development and production, W.D. specification and civil co-operation.

The whole subject is treated so clearly and thoroughly by Major Kuhne that the German reviewer finds he cannot do better than give a literal translation.

The Paris Automobile Exhibition, 1927. This show, the first since 1913 to admit German exhibits, is dealt with by Dr. Stadie. Only cars, motor-cycles, and accessories were shown, lorries being reserved for exhibition later. Of 112 firms exhibiting, 73 were French, and four firms together (Citroën, Renault, Peugeot and Mathis) furnished over 75% of the total exhibits. The Exhibition thus presents a complete picture of the extraordinary extent to which the French automobile industry is split up. In consequence of the high protective tariff (45% !), it continues in a state of the highest inflation, and of constructional tendencies being carried to extremes. Dr. Stadie considers that there are four main causes of this state of affairs, (1) the above-mentioned high protective tariff, which, in spite of its unmistakable advantages to home industries, has also an unhealthy effect like that of a hot-house ; (2) relatively cheap labour and cheaper materials ; (3) complete dependence on foreign countries for power-spirit, which, in order to keep down running costs, has led to the development of vehicles as small as possible ; (4) the Frenchman's attitude towards his car, which he regards as a *petit bijou*. Nowhere in the world can so many Liliputian carlets be seen as at the Paris Car Show, all capable of doing their 60 m.p.h. In the catalogues one finds such speeds claimed for cars down to a cylinder-content of one litre.

The development of the French car can, therefore, hardly be described as happy. It combines the greatest possible lightness with low tractive power and poor acceleration.

The author then dismisses the British (Austin and Rolls-Royce), the Germans (Mercedes and Horch), and the 21 American firms, in a few words, and confines himself to French novelties. The drawings and photographs include : Imperia slide-valve engine ; cam-shaft drive of two-litre Lalage ; Berliet's additional gears ; Sara air-cooled 6-cylinder engine ; R.B. voltex magneto ; Cottin-Desgouttes springing of rear axle ; Harris Léon Laisne rear-axle drive and springing ; effect of an obstacle 8 in. high on one wheel of Harris Léon Laisne rear-axle ; Farman suspension and steering ; Claveau $1\frac{1}{2}$-litre car with 4-cylinder air-cooled engine in rear and independent wheels.

The Telegraphy of Pictures and Handwriting. Lt.-Col. Boelcke manages to compress into four pages of the magazine, not, indeed, an account of picture-telegraphy, but an outline of the Telefunken-Siemens-Carolus system, and tells of some of its trials and achievements. He points out what the valve has done for P/T, as amplifier, transmitter and receiver, in making it practical : touches on the work of conversion from light to electricity, and back again, by the Telefunken-Photocell at the sender, and by the Carolus cell at the receiver : gives some account of the Kerr-effect and nitrobenzol : even, of synchronization ; and shows how a picture 10 x 10 cm. in area is touched off in parallel lines ·2 mm. apart by means of a point of light ·04 sq. mm. in area. A picture of this size thus contains 250,000 picture-elements, and should reproduce very clearly, *i.e.*, to the naked eye, the reproduction of the photograph, and should itself look like a photograph.

The combined sender and receiver is called the Carlograph. It has been on trial since 1926 between Nauen and Rome, and between Nauen

and Rio (6,000 miles), working five nights a week sending pictures and handwriting on wave-lengths, first of 30 metres and later of 25. The times taken for a 1 sq. dm. picture, as above, are Nauen-Rome 80 seconds, Nauen-Rio 5 minutes (corresponding to 60–80 w.p.m. of Morse, which is above hand-speed). Between Berlin and Leipzig the same-size picture has been received on 850 metres in 30 seconds (corresponding to Morse high-speed). Atmospherics do not affect these pictures appreciably, appearing only as fine broken lines.

As regards the utility of picture-telegraphy and its future, the Army will find it indispensable for meteor charts, and, if introduced far enough forward, it will be able to give information which it is hard to express in words, thus saving cumbersome (and often inadequate) references to the gridded map in the body of the telegram.

In the matter of sending messages overseas, Lt.-Col. Boelcke modestly claims second place for facsimile telegraphy after the aeroplane or airship. It is, however, not easy to see how these latter will ever be able to compete over long distances with a message-carrying agency which can convey a message in perfect facsimile 6,000 miles in 5 minutes!

The future of picture-telegraphy across the seas will rather be the conquest of the mail-bag. Business firms will not send important letters too long for cabling on journeys of weeks to Australia, S. America or Japan, when at reasonable cost they can telegraph in facsimile and receive an answer in 48 hours. Even private people who can afford it will do their correspondence that way.

As regards the question of Electrical Vision, the Carolus cell is capable of dealing with 100,000 picture-elements in a second, *i.e.*, with 10,000 in 1/10th of a second, which is both the duration of time a light-impression affects the retina, and the period within which all light-impressions received appear simultaneous. With only 10,000 elements to the picture, we must either abandon all idea of getting the same degree of definition as in the Nauen-Rio trials, or be satisfied with a picture 2 x 2 cm., say 1 in. square. Further, for electrical vision the chief difficulty is the adequate illumination of the object, since the light-electric cell is not sensitive enough for ordinary light. When it is a question of broadcasting films, the matter becomes simpler, for the film can be directed so that a ray of light from a powerful source passes through it. That special case of electrical vision, the broadcast cinema film, may, therefore, be expected to arrive before electrical vision proper.

A footnote to the article, saying that permanent picture-telegraphy was established between Berlin and Vienna on December 1st, 1927, is misleading to this extent, that the article deals with wireless picture-telegraphy throughout, that the Telefunken-Siemens-Carolus is a wireless system, while the P/T established between Berlin and Vienna on 1.12.27 was done only by taking advantage of the then recently-laid Berlin-Vienna cable.

Mechanical Transport and War. The translation of Col. Maltese's article from the Italian finishes in this number. This third instalment, dealing with artillery tractors, tanks, armoured cars and M.T. columns, is too sound for exception to be taken to any points.

The author points out the effect that army M.T. requirements in war

must have upon civil M.T. construction in peace, and sums up: A far greater use of M.T. will be necessary in future than was the case in the last War; animal transport will be confined to first-line troops in mountain country; there will be no horsed transport in Corps or Army areas. The wide extension of M.T. in armies will introduce a different time-scale, tending to bring about a very severe but very short period of mobile warfare. There will be incorporated into every army of fighting men a second army of engines and steel, and these two armies must be welded into solidarity in order to afford the necessary mutual support under all circumstances. Every effort must be made to instil into the troops an instinct-like feeling for the technical side. A spirit of disciplined economy will form part of the true understanding. If the troops are so trained, M.T. will gain in its powers more than if it was doubled in numbers.

With all this the German translator cordially agrees.

The Significance of the Air Forces. Certain photographs, which appeared in *Flight*, of detachments of the 53rd and 54th London A.A. Artillery Brigades taking part in the Lord Mayor's Show, and of a DH9 accompanied by auxiliaries, have given rise to an instance of relativity. To the German reviewer they "throw a characteristic light on how far the recognition of the significance of the Air Forces has penetrated into all classes of the population in England." The gallant Territorials who sacrificed themselves on this occasion, in order to give their units a much-needed advertisement, and in the hopes of attracting a few recruits, will find the German view singularly refreshing.

F.A.I.

MILITÄRWISSENSCHAFTLICHE UND TECHNISCHE MITTEILUNGEN.

(NOVEMBER–DECEMBER, 1927, CONTINUED.)

Chemical Warfare and International Law. The author of "Chemical Warfare," Dr. R. Hanslian, (*R.E. Journal*, March, 1928), reviews a pamphlet with the above title by Dr. Kunz of Vienna. The reviewer finds no fault with Dr. Kunz's conclusion that the German gas attack at Ypres on 22nd April, 1915, was no breach of international law, but is surprised to find that the use by the French of gas shells (Phosgene) early in 1916 "cannot be proved conclusively to have been contrary to the international law which was valid at the time." When the result of Dr. Kunz's "excellent labour, built up on a wide knowledge of literature, brilliantly formulated and carried through with astonishing logic," leads him to demand by means of international treaty an unconditional ban on the use of gas in war, not only of poison gases but of irritants, Dr. Hanslian can only call it "tragic." He thereupon sets himself two questions to answer, viz., Can—and should—chemical warfare be forbidden? As regards possibility there are two standpoints, tactical and technical. "As long as war is the *ultima ratio* of nations so long will chemical means of warfare be retained, since in the war-history of all countries and times

no case is known in which a tactical advantage or a successful new weapon was ever given up again, once its value had been recognized and proven, excepting only to be ousted by a better one." The tactical answer is therefore " No." Again, at the conference at the Hague in 1899 it was pointed out that " the occurrence of poisonous gases (Carbon monoxide, Nitrous gases, Picric Acid) from the explosion, especially of shells of large calibre, was absolutely unavoidable and so could not be forbidden except by forbidding the use of all explosive shell." In the development of shell-ammunition which is to be expected in future, both in the form of shell of large calibre and of aerial bombs or torpedoes, in all of which new detonation gases, or in certain cases deflagration gases, will occur, we may expect that the line between explosive and gas will be wiped out to a still greater extent. Also, the use of smoke for protection will certainly increase, and will complicate the unequivocal determination of the use of gas by the enemy. It will in all probability be extraordinarily difficult in future wars, in cases other than that of discharge by cylinders in large numbers, to determine with certainty whether the enemy has in fact made use of gas or not. In such uncertainty lies the germ of misunderstandings and of reprisals, as we saw in the Great War. Thus the possibility of excluding chemical means from future warfare cannot be admitted from a technical standpoint.

The second question remains, and may be expanded thus: Supposing it were possible to frame international laws forbidding any intentional use of typically poisonous and suffocating gases, should this be attempted? The author thinks not, considering the matter of no great importance, inasmuch as war experience has shown that the most poisonous gases were not the most militarily effective. The gases which were the most militarily effective were the harmless ones, like the lachrymatories, which caused no deaths, or like the vesicatories, which killed one-tenth the number killed by explosive-shell. In other words, the poisonous and suffocating gases of the Great War will rule themselves out in future wars as ineffective, without being forbidden. There is still, of course, the possibility of new gases being discovered, both poisonous and militarily effective, but such surprises through some specially effective weapon are not limited to chemical means, and are consequently no reason for forbidding a means of fighting of which the development has hitherto been more humane.

As regards the latter point Dr. Hanslian records the unanimous decision of the American Legion, or comrades of the Great War, in their annual congress at Philadelphia, that the use of chemical weapons should be permitted in future wars, and that to forbid this method of fighting would be tantamount to wishing to replace a modern humane method of fighting by earlier barbaric methods.

Railways in War (continued). By General Ratzenhoper. The military effect upon the national railways of the movement of troops to war stations and the military capacity of the railways were laid down in the War Traffic Regulations. In order to guarantee the safety and regularity of ordinary traffic these Regulations arranged for all military trains to travel at slow speed, to take the same time between stations, and to have the same length of halts. As this procedure has come in for much

criticism it may be as well to examine it more closely. Since the forward movement by train lasted some weeks, the decisive factor, in converting troops which are ready to move to the theatre of war into troops in the field, is not the speed of the trains but the total number of trains moved in a given time. If, as was the case, owing to the large amount of rolling-stock available, troops have not to be kept waiting for trains to be returned from the front, the time their journey takes is of quite subordinate importance. The objection that later in the war military traffic moved much faster proves nothing, since more powerful locomotives were constantly being provided. It was reasons of safety which, at the beginning of the war, dictated a system which made all troop-trains halt at rationing places for the same length of time as a ration-train took to load; but the system was changed later when the position as regards locomotives improved and when the lines leading forward were no longer all required for military purposes at the same time.

The rest of the article deals with the arrangements for the evacuation of wounded, the provision of coal (so that no coal trains were required for the first eight weeks of war), guarding against sabotage (83,000 men were employed and the total loss was one bridge), the provision of break-down gangs, the provision of spare bridges, the arrangements for possible demolition (137 tons of explosive in 309 built-in mine chambers).

The author also disposes of the complaint against the military authorities that they held up the electrification of the Austrian railways. —(*To be continued.*)

The Future of the Infantry Rifle. Major Markgraf leads up to his subject by pointing out the position of the rifle at the beginning of the Great War, when in masses it was the chief means of conducting the fight for fire-superiority, while the *rôle* of the few machine-guns then existing was to increase the fire-effect of the infantry. The machine-gun, in 1914 still a new weapon, was being used only tentatively, but its powerful fire-effect was soon recognized, and the call for its increase in numbers became loud. Besides this, the second half of the War produced the light m.g., which more and more took over fire-effect, leaving to the rifleman mobility and shock-tactics. The m.g. in taking over the mass-fire of the infantry rifle became the principal support of the infantry combat at all ranges. According to modern views, the infantry rifles, no longer appearing in masses, are to be brought as much as possible without firing a shot to short-range, say 500 m., and then for the first time, and subsequently at close quarters, are to complete the effect of the m.g's, heavy and light, and of the artillery. It is no wonder that, since the War, under the pressure of new weapons, the *rôle* of the infantry rifle has in many directions been regarded as played out: the idea being that the m.g. conquers the ground, the infantry, with their sparse numbers still armed with the rifle, only occupies it.

It is in respect to the development and views mentioned that the author now sets himself the task of determining what is to be the future of the infantry rifle. Comparing the pre-war requirements of the rifle with the demands now made upon it in accordance with modern opinion, he finds that the chief difference lies in the greatest possible range no longer being demanded. The heavy m.g. has taken over from the rifle

fire-effect at medium and long ranges, and to this weapon the demand for increase of ranges has passed over. Low trajectory for the rifle is no longer of importance beyond the 500 m. limit set by the depth of the fire-fight zone. Rapidity of fire is of increased importance. The War showed the deficiency of the magazine-rifle in this respect, a partial remedy to which was brought out by the Germans in the shape of a 25-cartridge magazine. The new rifle must, therefore, be automatic. There is ample justification for this demand, and the objection of possible waste of ammunition is hardly worth consideration. The same objection was made to the introduction of the magazine-rifle. The infantry rifle will certainly have to fire very rapidly, but generally only for the utilization of rapidly-fleeting opportunities. It will not be kept in continual use, but will be required normally for sudden short bursts of fire at short ranges. As regards calibre, universal calibre or the same cartridge for rifle and for the different types of m.g. cannot be maintained. Only the light m.g. can still be classed in this respect with the infantry rifle. With the heavy m.g. two kinds of ammunition are necessary, differing in shape of bullet and in charge, apart from the different m.g. calibre for anti-tank defence and A.A. defence, and special ammunition (tracer, armour-piercing, ranging). The necessity of special ammunition (armour-piercing and tracer) for the automatic rifle, also materially influences the calibre question. The lowest limit for the manufacture of such ammunition is 7 mm. This calibre is ballistically suitable for the light m.g. as well as for the new rifle. It allows of a very necessary increase in the number of rounds carried by the man, 120 of 8 mm. (·255 in.), without increasing his load of 9 lb., sufficiently preserves man-stopping power, and permits the manufacture of special ammunition. The article concludes by pointing out that under the leadership of the United States the present armed nations are tending to the light m.g., followed by the automatic rifle.

The Officer and War Technics. This essay, by Major Angelis, was a prize-winner in a competition for the best answer to the question, " To what extent is a knowledge of war-technics necessary for every officer ? " It is carefully written, logical, well thought out, and full of statements which are incontrovertible ; in fact, it is exactly what is supposed to please most examiners. There is little trace of originality or of brilliance of thought or diction ; and disappointment awaits him who reads eagerly in order to learn. Since the new truths of the older generation are the platitudes of the young, a Board of Examiners consisting of Woolwich and Sandhurst cadets would probably have marked this essay low. They would have been wrong. The essay must be praised, even if it is praised with faint damns.

After defining Technics as the translation into reality of the development of science, the author divides War-Technics into two classes : (*a*) Weapons, chemical warfare, signals, and military engineering, (*b*) Transport and aviation. His answer may be summarized as follows :— On the foundation of a certain general education and a thorough military education (extending in the former case to such a stage of mathematics and science as to make possible the technical studies of the latter), all officers are to continue their education in war-technics. Their object

to be, not so much actual knowledge as such, but the knowledge that increases understanding. Such study to be undertaken under expert guidance, and to be practical rather than theoretical, since war-technics, concerned with material, has become an indispensable ancillary in the art of war, which remains a thing of the spirit.

Flash-Spotting and Sound-Ranging. The translation of an article written for the Czecho-Slovakian army, in which these artillery aids are unknown. It deals with reaction-errors, the effects of temperature and wind upon the velocity of sound, and the correction of range owing to height differences—in short, with the elementary theory of the subject, and makes no mention either of apparatus or achievements.

The Technical Arms and Services. Col. Paschek having dealt with the Engineers in his last article, now continues with Communication-troops, under which heading are grouped together services as diverse as Signals and Transport (Railways, Water Transport, Mechanical and Horsed Transport, and Air Transport). The modern army spends on communications out of all comparison more than has hitherto been spent for these services. Needs continually grow, and technics are progressing. Excepting in Railways and Horsed Transport everything is very much in a state of flux.

Like Engineers, Communication-troops tend to become increasingly "Arms," and not "Services," depending in this case on whether they are serving operations or supplies, G. or Q.

As the first of the group, Signals are then dealt with under the headings "Means," "Principles of Employment," "Principles of Organization," "Signal Troops," "Regimental Signals," "Peace Organization," "War Organization." As he did with the Engineers, the author endeavours to show in some detail under "War Organization" what he considers the Signals of the great military powers are becoming. He points out that England, which is leading in mechanization, is likely to be the first to go over principally to wireless. This, as a fact, had already been tried out in 1922, when, under Lord Cavan as C.I.G.S., cable temporarily disappeared from the equipment of signal units, remaining only within the artillery and infantry formations. (*To be continued.*)

Permanent Fortification (*concluded*), by Col. Schneck. After having, in his last instalment, considered the *rôle* played by permanent fortification in each of the theatres of the Great War, the author points out considerations which must be weighed when judging the value of permanent fortifications. He sums up, "that permanent fortifications will, in future, also be necessary there is no longer any doubt. Only about the way it is to be carried out opinions differ strongly." He is quite certain, however, that the *isolated* girdle-fortress has played its part, since even the largest fortified towns can nowadays be shot to pieces by long-range artillery, supported by aerial bombardment. Against these means of attack only the widest spreading can help. Thus, in place of the girdle-fortress, and in accordance with the principles for the construction of field positions, we must have the *deep fortified* zone.

Hence, if permanent fortification is looked upon as necessary for frontier protection, or to cover the approach march in the territory of

manœuvre, it can only be provided as a *fortified front* necessitating due provision against out-flanking.

For the design of permanent fortifications proposals differ very widely. France, in its incessant care for the protection of its frontiers, is occupied intensively with these questions. Thus, one French proposal is to have two continuous infantry lines at a distance of 500 m. apart, and 1,000–1,500 m. farther back a line of scattered *points d'appui*, equipped with the most modern means, while all further requirements are left to the period of mobilization. Another proposal advocates permanent completion, according to the principles of area-fortification—guns, m.g's, o.p's to be armoured, shelters and dug-outs to be blasted out of the rocks or built in concrete, obstacles, communications, and signal arrangements to be put in permanently. Very important is the utilization of artificial inundations or swamps as tank obstacles, and also a continuous cleared field of fire along the front. It is obvious that there is no technical impossibility about carrying out such works. It is only a question whether even a rich nation can afford the luxury of such fortification. Also the principle of economizing troops no longer holds good: all that matters is to be speedily prepared for battle.

The French Defence Proposals of Poincaré of 1927 envisage the building programme of a powerful chain of fortresses from the North Sea to the Riviera at an estimated cost of £280,000,000, to be spread over seven years, till 1935. There is proposed a deep zone consisting of many *points d'appui*, with obstacles, and including railways, broad gauge and field, detraining-stations, roads, telegraphs and telephones, aerodromes, and the building of command head-quarters and depots for R.E., Ordnance, and A.S.C. stores. On such a grand scale does France wish to defend against break-through by the enemy its thrice-barricaded Eastern frontier, "the most open and the most threatened in the whole world."

In contrast to this scheme we are given the author's own ideas. "Since it is generally possible to build quickly in the area of manœuvre positions which are capable of offering a good resistance, when good communications, ample building-material, labour, shelters, and water are present, it will be best to make certain of all these needs, to have all plans prepared, and to carry them out when the time comes, according to the latest achievements of technics." Bomb-proof dug-outs and complicated flanking arrangements are to be provided in peace as the skeleton upon which field fortifications are to be applied. It is a question, also, whether peace should provide lightly (*i.e.*, against medium artillery) armoured o.p's and m.g. posts. Excellently-built communication network is in any case a *sine qua non*.

The series of articles concludes with some notes on the application of permanent fortification to mountainous country.

F.A.I.

REVUE MILITAIRE FRANÇAISE.

(*April*, 1928).—Commandant Roques completes "*L'organisation du terrain d'opérations de Champagne pendant la guerre mondiale*" in this number. A mass of statistics referring to administrative measures,

which had to be taken in the back areas, is given; the interesting part of the article lies in the conclusion. The writer estimates that a modern army cannot work efficiently more than 45 miles from its organized railway system. This is a conclusive answer to those who criticized the acceptance of the Armistice in 1918, but we must not necessarily take the conclusions of 1918 as holding good for a future war with mechanized weapons.

"*Au Maroc français en* 1925. *Le rétablissement de la situation militaire*," by Capitaines Lacau and Montjean, is completed in this number. The writers deal with the training, moral and material, required to reinvigorate the French troops before their final success. Certain lessons of the Great War had to be unlearnt before the French forces became really efficient. Once the forces were modelled in the way required for warfare of this kind, brilliant and stable results were achieved in a short space of time.

"*Les débarquements de vive force*," by Colonel Alléhaut, begins in this number. The writer considers that combined operations have not been studied sufficiently in the past, and his object is to indicate the various stages of this type of operation. In this instalment he points out the two essentials of secrecy and speed, and then describes the preliminary questions which have to be considered, including the selection of the necessary advanced bases, both for sea, land and air forces. While no attempt is made to give details, the various stages are clearly set out.

Lieut.-Colonel Desmazes and Commandant Naoumovitch complete "*Les victoires serbes en* 1914," in this number. The Battle of the Koulabara, which took place during the first half of December, is described in considerable detail. The Austrians, who had advanced a long way into Serbia, and who were on the point of continuing their attacks, were driven back by a sudden counter-thrust of the Serbs, and by the middle of the month had been forced to re-cross the Sava River. This was a most brilliant operation on the part of the Serbs, as they were almost completely lacking in munitions; unfortunately, it brought them little nearer contact with their allies, and they had to wait for nearly four years of anguish before their victory was completed.

The third instalment of Colonel Armengand's important article, "*Les enseignements de la guerre marocaine en matière d'aviation*," appears in this number. Special attention is given to the use of aircraft for bombardment in mountain warfare. The less efficient artillery becomes, the more aircraft can be used against an enemy who neither possesses an air force of its own nor efficient anti-aircraft weapons. Many interesting examples of this use of aircraft in Morocco are given; apparently, on certain occasions, artillery fire was almost entirely replaced by fire from aeroplanes. The writer is convinced that really strong air forces are required in this type of savage warfare, and he marshals his arguments clearly and convincingly. Several excellent oblique photographs illustrate the article.

"*Les fortifications permanentes de l'Allemagne en* 1927," by C.L.L., describes briefly negotiations between the German Government and the Ambassadors' Conference since the Great War. The Peace Treaty of

Versailles took away from Germany her Western fortresses, and it seems that now her only strong permanent defence is in East Prussia.

(*May*, 1928).—Commandant d'Argenlieu begins "*La bataille de l'Avre*," in this number. The instalment describes the opening stages of the operations at the end of March, 1918, just south of the British 5th Army. It is rather difficult to pick out the salient points from the mass of detail that is given.

"*Les enseignements de la guerre marocaine en matière d'aviation*," by Colonel Armengand, is completed. The writer's conclusions are most interesting, but whether the results of semi-civilized warfare can be applied, as completely as he thinks, to European war is open to doubt. The view is put forward that, in battle, the main task of aircraft is to join with the other arms in crushing the enemy's field forces, rather than to attack back areas, and for this purpose an air force "of the line" capable of undertaking a large number of different tasks is required. Whether the reader agrees or not with Colonel Armengand's conclusions, the article is well worthy of study.

"*La défense du Bois de Ville et de l'Herbebois*," by Lieutenant-Colonel Paquet, begins in this number. The description is of the action of the 51st Division in the German attack on Verdun in 1917, but it is of little interest to anyone who did not take part in the Battle. This instalment describes the preliminary measures; the mistake of holding the front line as the main line of defence is very obvious.

Colonel Alléhaut concludes "*Les débarquements de vive force*" in this number. A clear description of the various steps required in combined operations is given, including the formation of the "first flight," and the rest of the covering force. An interesting point is the hour to be selected; the writer favours the night, an hour or two before dawn, so as to give time for the beaches to be cleared before a dawn advance. The whole article forms a good outline description of combined operations.

"*La dernière offensive d' Abd-el-Krim*," by Général Vanbremersch, describes the Rif leader's final effort before the eventual Franco-Spanish Advance. The sketches illustrating this instalment appear in the June number, but even without following the details on the map, the account of the attack is interesting. The onslaught was a complete surprise, and various defensive posts were completely cut off. The instalment ends with the orders given to effect the relief of these posts.

(*June*, 1928).—Commandant d'Argenlieu continues "*La bataille de l'Avre*," in this number. The period up to the end of March, 1918, is described in considerable detail, during which the French were forced to fall back on the British 5th Army. Three maps are given in illustration of the operations.

"*Autour des batailles de Napoléon*," by Général Camon, is a discussion of a favourite manœuvre of the Emperor, that of holding the enemy in front while an outflanking force strikes in on his line of retreat. In this instalment the writer describes the Battle of Marengo and points out that Napoleon was unsuccessful in his efforts to direct this battle

"according to plan." He then quotes from an account written by Napoleon at St. Helena, describing the battle as it should have been, rather than as it was, for the benefit of posterity. More successful battles of this type are to be considered in future instalments.

Général Vanbremersch concludes "*La dernière offensive d'Abd-el-Krim*" in this number. The French counter-attack on the plateau of Issoual, which had been captured by the enemy, is described. The counter-attack was successful and the captured posts were relieved; this action marked the beginning of the end for Abd-el-Krim. The writer's comments are interesting; he points out that whereas Abd-el-Krim's conception was excellent, the lack of command of his troops caused his attack only to reach a portion of the objective. Instead of masking the French posts and pushing on, the enemy wasted time in attacking them with a view to pillage. On the other hand, during the French counter-attack, threats of envelopment, directed by Commanders on the spot, were immediately successful in turning the enemy out of the positions they had gained.

In continuing "*La défense du Bois de Ville et de l'Herbebois*," Lieut.-Colonel Paquet describes the outbreak of the German attack on Verdun, on the front of the 51st Division. It is the usual description of a tremendous bombardment followed by the infantry attack, opposed by small counter-attacks which had little effect, as it was quite impossible to organize them, the German bombardment having destroyed all means of communication apart from runners and dispatch-riders.

"*Le système des récompenses dans les armées romaines*," by Capitaine Andrieux, follows a previous article by the same author, on punishments in the Roman Army. Rewards were either honorary, such as bracelets, crowns, etc., culminating in the triumph, pecuniary or actually in kind. The last consisted sometimes of extra rations issued to units who had earned the award.

H.A.J.P.

REVUE DU GÉNIE MILITAIRE.

(*March*, 1928).—The first article, by Doctors Edmund and Stephen Sergent, deals with the suppression of the anopheles mosquitoes in the neighbourhood of camps. Their method is based on the fact that in the climate of the Mediterranean the life of the larvæ averages three weeks in summer. Therefore, in arranging the drainage of places where water is likely to stand, two channels to be used alternately week by week should be constructed. The drying up of the channel not in use destroys all mosquito larvæ in it.

An article, by Lieut.-Colonel Grelier, called "Ten Days on the Aisne with the 14th Division," describes the part played by the engineers in the operations from September 11th till September 20th. It included the repair of the road bridge at Vic, damaged by the Germans in their retreat on September 12th, and the construction of another bridge to take motor lorries, in which barges were used as piers, the superstructure being made from material obtained locally.

There is an interesting article, by Chef d'Escadron J. Veyrier, called "The Use for Military Purposes of Multiple Arched Dams." The advantages of the simple arched dam over the straight dam, depending on its mass for its stability, are well known. The use of reinforced concrete is responsible for the introduction of the multiple arched dam, in which the hydraulic pressure is transmitted to the sides of the valley, not by one arch only but by a series of small arches, with parallel axes supported by vertical buttresses of reinforced concrete. The subject of the article refers to an extension of this system. The principle consists in dividing the dam into a number of walls, decreasing successively in height, in the down-stream direction. Between each pair of walls the water stands on a level with the tops of the lower of the two, so that that part of each wall which is in contact with water on both sides is subjected to a pressure corresponding to the difference between the levels of the two adjacent strips of water.

Whether each wall is constructed on the simple or multiple system of arches, it can be of uniform thickness for the greater part of its height.

The writer describes how the principle can be applied for military purposes by using steel sections of fixed pattern for constructing the dams.

There is a continuation of the "Sieges of Przemysl," by Colonel Beyer.

(*April*, 1928).—"The Use of Wire Gabions filled with Stones, on the Roads in Northern Morocco," is the subject of an article by Lieut.-Colonel Puissant. The Gabions described are much the same as those used on the Indian frontier for river training and bridge protection. They were used in Northern Morocco for :

Protection of bridge piers against scour.
Protection of river banks.
Construction of a road on subaqueous foundations.
Abutments and floors of culverts.
Revetments of slopes.

There is a translation, by Colonel Beyer, from the *Militärwissenschaftliche und Technische Mitteilungen* of an account of the second investment of Przemysl.

(*May*, 1928).—A long and interesting account of "Works Carried out in Morocco by the Service des Routes de l'Armée," is given by Lieut.-Colonel Puissant.

The personnel available in that department consisted of :—

(1) A varying number of companies of engineers.
(2) Moroccan labour companies.
(3) Native civilians (organized in gangs of 20 to 50, under a headman, and paid 8 to 10 francs per diem).
(4) Occasional military working parties.
(5) Selected civilian overseers.

Tools and materials were supplied from headquarters at Fez and Taza.

Works had to be carried out rapidly and as it was impracticable to make a regular preliminary survey, the following method was employed :—

(1) Possible routes were obtained from the map or from information.
(2) Reconnaissance was made by " clysimètre " and barometer of those which seemed the best.
(3) After discussion a line was chosen and a rapid compass survey made.
(4) The principal difficulties were examined and studied on the ground.
(5) A provisional line was marked on the ground by heaps of stones.
(6) A section was made by " clysimètre " or level.
(7) A path was constructed on that line to facilitate detailed study and sometimes by a track for the conveyance of material and rations.

Works were designed so as to reduce to a minimum the employment of artisans, who, except for masons of no great skill, were very difficult to obtain. The use of piles in river beds was avoided as far as possible. " Pigeaud " bridges were used for spans of 17½ to 37½ metres, bridges of girders and concrete for spans of 3½ to 9½ metres constructed in accordance with type designs. For spans of 1 to 3 metres, semi-circular masonry arches were used. For smaller spans tubes of not less than a half-metre diameter were used, usually old oil drums, encased in concrete.

Roads were for one line of traffic, and were 4 metres wide. Maximum gradient was 6 per cent., rarely 7 per cent. for short distances.

Several large bridges were constructed and about 165 miles of metalled roads between various places.

The writer gives an interesting account of these works, with plans of some of the bridges and a map.

Colonel Tricand contributes an article in which he describes a graphic system for finding the charges for mines to form road craters.

There is a continuation of the translation of " The Second Investment of Przemysl."

A.H.B.

CORRESPONDENCE.

WIRE-NETTING ROADS.

THE following correspondence on the subject of the origin of wire-netting roads, part of which has already appeared in the April, 1928, *Supplement to the R.E. Journal*, is now published in the *Journal* itself, as being of general interest.—[EDITOR].

Manchester Corporation Tramways,
General Offices: 55, Piccadilly,
Manchester.
15th March, 1928.

SIR,

My attention has been drawn to a paragraph in the *Daily News and Westminster Gazette* that you were endeavouring to trace the origin of the wire roads in the Sinai desert.

I made numerous enquiries myself whilst there, but was unable to locate the individual to whom the credit may be due. The history, however, I understand to be as follows :—

A quartermaster-sergeant at Kantara noticed how easily he could walk on the sand when wire netting was spread out, being cut to lengths for service. With the usual quartermaster-sergeant's longing for comfort, he laid a stretch of such wire between his tent and the stores. This was noticed by an R.E. officer, and by him subjected to sufficient trial, the outcome of which was, as is well known, the miles of excellent roadway.

I have pleasure in submitting this information for what it may be worth.

I have the honour to be, Sir,
Yours faithfully,
HENRY MATTINSON, *late Major, R.E.*

To Brigadier-General J. E. Edmonds, C.B., C.M.G.,
O. i/c Military Branch, Historical Section,
Committee of Imperial Defence,
2, Whitehall Gardens, S.W.1.

British Legation,
Santiago,
Chile.
2nd May, 1928.

The Editor, *The Royal Engineers Journal.*

DEAR SIR,

The reply to Major Mattinson's enquiry in the April *Supplement* is that the wire roads were *evolved*, not *invented*; and that the place of their evolution was not Sinai.

It happened in this wise.

In about the month of November, 1915, the Command in Egypt had to take measures to counter the threatened invasion of the Nile valley by the Senussi Arabs of the West. Amongst the measures was the location of a strong detached post covering the little oasis of El Moghara, some 90 miles south-west of Alexandria, and some 30 miles south of the station on the 'Alexandria-Dabaa railway from which the garrison was supplied by motor convoy.

This motor convoy, finding the surface of the desert track cutting up badly under the wheels of their Ford cars, laid down rushes obtained from the oasis on the worst patches.

For some days all was well! Then arose a gale, which removed the carefully laid rushes, and repeated the process at frequent intervals, until the rushes in one particularly bad short stretch of track were anchored down with strips of wire netting diverted surreptitiously from some more orthodox use. All was well again!

But the war went on, and the sun beat down and dried up the rushes under the wire, so that they eventually disappeared completely under the grinding of many Ford wheels. Strange to relate, all was still well! Wheels, and, still more so, ammunition boots, continued to pass lightly over the surface of the sand, with only the netting in between!

Thus was a great invention "evolved." It soon became customary for cars doing desert patrols to carry wire instead of planks to help them through soft places.

Thus far I claim to speak with the authority of personal knowledge, having been G.S.O.1 of the W.F.F. at the time. Should confirmation be needed, it can doubtless be found amongst the records of the Pembroke and Montgomery Yeomanry, who (dismounted) formed the garrison of Moghara post under the command of Lieut.-Colonel (late Brigadier-General) Lloyd.

At a later date, when *liaison* measures commenced to span the wide gulf hitherto fixed between the small and unfashionable Western Frontier Force of the Libyan desert and the Mediterranean (later Egyptian) Expeditionary Force, then on the Suez Canal (which forces owed allegiance to different members of the trinity of High Commands who directed military affairs in the Near East), apostles were dispatched by the W.F.F. to impart the results of their desert experience to the E.E.F.

I am not certain which of the apostles was definitely charged with extolling the virtues of the wire road, but strongly suspect a "light car patrol," which demonstrated at Ismailia and Kantara various aids to getting a Ford car over the desert, including the water condenser, the sun compass, and the use of wire netting.

Another somewhat similar point which appears to have given rise to uncertainty is the authorship of the Suez Canal inundations. The authentic author is much too modest to settle the matter himself, but will, I hope, forgive me for disclosing his name in an endeavour to prevent the credit being given to yet more persons, only *some* of whom have disavowed it. It was Colonel (afterwards Major-General) H. B. H. Wright (R.E.), my very-respected chief during much of the War, who planned and ordered the execution of these inundations.

In consultation with Sir William Willcox (the irrigation engineer and

antiquary), and with the Suez Canal authorities, he decided to admit the salt water of the Canal into the ancient river-bed and swamps of the old Pelusiac branch of the Nile, whose course intersects the canal, but which has been dried up and largely obliterated by sand since many centuries before the Christian era.

The necessary cuts were made in November, 1914, and the resulting inundations covered three-fourths of the distance between Port Said and Kantara, thereby shortening, permanently and at negligible cost, the defence line by some 25 miles.

Yours very truly,

R. E. M. RUSSELL, *Colonel.*

SCIENTIFIC SOLDIERSHIP.

The Editor, *The R.E. Journal.*

SIR,

The claim of the exponents of "Mechanized" warfare, and particularly of the protagonists of armour, that the development of the tank will necessarily lead to a reversion to mobile warfare is of more than ordinary interest to those members of the Corps who are, like myself, "Specialists" in Survey.

If this claim is substantiated, it must entail very sweeping changes in present survey policy, and many of the survey methods evolved during the Great War, particularly those connected with Artillery, will have to be scrapped altogether.

These methods proved their value in France, and we now spend not a little time and trouble in training officers and men in their use; but they refer only to indirect fire, and would have no place in the sort of warfare envisaged by the tank "experts."

It is not, therefore, in any captious spirit that I ask you to allow me to put a few questions through the medium of your pages, to the distinguished author of "Scientific Soldiership."

He tells us that "infantry are likely to disappear because they cannot protect themselves against armoured machines"; does he not mean "infantry as at present armed"? For is it not true that the foot soldier, *appropriately armed*, can defend himself quite easily against such machines? The trouble is, surely, that the weapons he requires for this purpose will not defend him against other infantry.

If our possible adversaries agree with Colonel Fuller that it is "better to replace existing arms by tanks," it would be necessary for us to change our "infantry armaments," for no one but a lunatic would try to attack a tank with a bayonet, but it is reasonable to ask Colonel Fuller to explain why this is impossible before his claim that only "tank can attack tank" will be admitted.

He contends that "it was the bullet on the defensive which rendered the war static," and that the "obvious answer was armour plate." As the bullet has been on the defensive many times before 1914 without rendering war static, I venture with all diffidence to challenge both these

assertions, and to ascribe the static nature of the War to the following two causes.

(1). The inability of the attack to establish that superiority of fire over the defence which our *F.S.R.* correctly told us was an essential prelude to movement in the immediate vicinity of the enemy.

(2). The ability of both sides to form a continuous defensive line between impassable flanks.

I suggest, then, that the obvious answer to the " bullet on the defensive " is still, as it has long been, not armour but another bullet, aimed straighter and carrying further.

Colonel Fuller will doubtless agree that the very core of the " unchanging framework of tactics "is the establishment of a moral ascendancy over one's enemies, and that the quickest and surest way of achieving this is by using one's weapons more vigorously and more successfully than they are able to do.

No soldier, scientific or other, will contend that armour is a weapon, or that it is possible to establish a moral ascendancy over anyone by hiding behind it.

In fact, at the risk of being called unscientific, I must confess that it seems to me that those who persist in carrying armour plate about them wherever they go, and hiding behind it whenever they come in contact with the enemy, are handicapping themselves by imposing serious and unnecessary limitations on their freedom of movement.

Other things being equal, *i.e.*, with equal power available on both sides, that combatant who carries the least armour will be the most mobile, or with equal mobility will be able to carry the heaviest guns.

How, then, can Colonel Fuller maintain that " the tanks (*i.e.*, the armour carriers) can stand off outside their effective range (*i.e.*, of the unarmoured forces) and bring heavy fire to bear . . ."

Surely the boot will be on the other leg.

Equally, how can they " ignore infantry and guns, and move still further in rear and attack the supply services ? "

Is it not more likely that these venturesome machines will be hard put to it to protect their own laagers against troops in more mobile vehicles who rely on guns rather than armour for their defence ?

Perhaps I am " prejudiced in favour of particular weapons," but I must say that it seems to me that Colonel Fuller is confusing the tactical attributes of armour and mobility, and is endowing the one with the virtues of the other. If it be true that he has fallen into this curious error, it must follow that his " area theory " and other deductions will require considerable amendment.

I am, etc.,

M. N. MACLEOD.

ARTHUR FFOLLIOTT GARRETT PRIZE ESSAY, 1928.

SUBJECT SELECTED:—WATER SUPPLY ON ACTIVE SERVICE.

AN expedition is to be sent to the Crimea to capture the fortress of Sevastopol. Its strength and equipment are those of the British Expeditionary Force first landed in August, 1914 (4 divisions, 5 cavalry brigades, etc.), but local conditions are as in 1854. The expedition may land where it actually did, or at Balaklava.

You are requested to advise the C.I.G.S. as to the provision of water on and after landing.

An account of the topography and climate of the Crimea, with some notice of the water supply, will be found in *The Medical and Surgical History of the British Army which served in Turkey and the Crimea during the Russian War in* 1854–5–6, Vol. II, p. 15.* In general, in 1854–6, water was obtained from streams, existing wells and springs. This was sufficient in winter, but inadequate for 70,000 men and 10,000 horses in summer.

It may be assumed that, by sinking additional wells to sea-level, sufficient water may be obtained, except in July-August, when the streams nearly dry up and 20 per cent. must be obtained by condensing sea-water. Possibly some of the well-water near the coast will be brackish.

Any assumptions found to be necessary from want of *Engineer Intelligence* must be clearly stated to be such.

Essays must reach the office of the Secretary, Institution of R.E., not later than the **30th November, 1928.** Essays must not be signed, but each essay must bear a pseudonym, and the name of the writer, enclosed in a sealed envelope marked with the same pseudonym, must be attached.

The following are the conditions of the Arthur ffolliott Garrett prize:—

1. The prize, which will take the form of a piece of plate, to be chosen by the recipient, was instituted by Mrs. Garrett in memory of her late husband, Major Arthur ffolliott Garrett, O.B.E., R.E.

2. Qualifications of the recipient: To be an officer on the Active List of the Royal Engineers, not above the substantive rank of Captain on 1st January, 1928.

3. The essay must not exceed **10,000** words.

* By the courtesy of the Librarian, the book can be seen at the War Office Library. *Professional Papers of the R.E.* have been consulted, but do not appear to contain anything on the subject.

Work of the Royal Engineers in the European War, 1914-1919.

For sale in the office of the Secretary, Institution of Royal Engineers, Chatham.

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Descriptive Accounts of Foreign Stations.—The following pamphlets have been revised and reprinted and are available, price to members, 1s. each :—

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(*Typescript only*) *Jamaica.* 6d.

Studies of German Defences near Lille.—A limited number of copies of this Report by Major B. T. Wilson, D.S.O. (with 35 maps and plans and 24 photos) are available for free issue to those members who apply for them to the Secretary. The price of the Report to the general public is five shillings.

An Outline of the Egyptian and Palestine Campaigns, 1914 to 1918.—By Major-General Sir M. G. E. Bowman-Manifold, K.B.E., C.B., C.M.G., D.S.O., *p.s.c.*, late R.E. Fourth Edition, 1928. With 17 maps and sketches. Price 4s. 6d.

History of the Corps of Royal Engineers.—Vols. I and II, by Major-General Whitworth Porter, R.E. Vol. II, by Colonel Sir Charles M. Watson, K.C.M.G., C.B., M.A., late R.E. Three Vols. £1 10s. (to members, 12s. 6d.).

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The Early Years of the Ordnance Survey.—By Colonel Sir Charles Close, K.B.E., C.B., C.M.G., SC.D., F.R.S. (illustrated). Price 6s. (to members 4s. 6d.) post free.

BLINDED IN WAR!

No man who wears the uniform of any branch of His Majesty's Forces can fail to be sympathetically interested in the way the men blinded in the War are fighting their handicap.

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has, since the early days of the War, undertaken the sole responsibility for the training, settlement and after-care of these men, and has given a pledge to help them in every possible way for the rest of their lives.

St. Dunstan's receives no State aid or Government grant whatever, and is entirely dependent upon voluntary help for raising the large annual income needed for carrying on its great work. St. Dunstan's responsibility does not end with the care of the men blinded in the Great War—it will care in the same way for men blinded in any future wars.

An appeal is made for each regiment to establish a "St. Dunstan's Fund," which, under the charge of a small Committee of an Officer, N.C.O.s and Men, would, by inviting small but regular contributions from all ranks, by organizing concerts, sports, etc., in further aid of the Fund, be able to make an annual donation towards St. Dunstan's for their war-blinded comrades.

Full details as to the best method of launching such a Fund, keeping interest in it alive, and simplifying its working, will be gladly sent on application to

THE TREASURER,
St. Dunstan's Headquarters,
Inner Circle, Regent's Park,
London, N.W.1.

COOMBE HOUSE, CROYDON.

THE R.E. Corps Committee would again like to draw the attention of officers to the advantages granted to the Corps in the provision of Coombe House, Croydon, as a place of rest for R.E. officers and their families.

Comparatively few have up to the present taken advantage of this opportunity of a free holiday in a beautiful country house offered by the generosity of a retired officer and his wife.

Visits can be arranged with the minimum of formality either by interview or correspondence with the Secretary, R.E. Corps Committee, Room 231, War Office (if desired, through the medium of friends in the Corps).

The only condition imposed is that applicants must be in need of a change, rest, or holiday, or even of somewhere to stay when their financial resources are somewhat strained.

It is thought that the scheme offers particular advantages to officers and their wives returning from foreign service, or when on half-pay.