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FoREM CRIMEAN WAR TOUR

25 SEPTEMBER – 4 OCTOBER 2004

THE plan for this year's tour is to travel further afield and to be a little more adventurous. As 2004 is the 150th anniversary of the battle of Balaclava what better place to explore than the Crimean Peninsula.

The tour is being organised for us by Midas and we have been fortunate to secure Richard Rutherford-Moore as our tour guide and Brendan McDonagh as our tour manager. Richard is an historian who spent the best part of five years in the Crimea serving as military advisor to the "Sharpe" series and has explored every aspect of the battlefields. Brendan who managed our 2003 tour so well is known to us and has expert and recent knowledge of the area.

We will fly from Heathrow with Czech Airlines via Prague to Kiev and then on across the Ukraine to Simferpol by overnight train in our own sleeping compartments.

Five nights will be spent in the three star Hotel Ukraine situated in the heart of Sevastopol. A further two nights will be spent in the four star historical Oreanda Hotel situated close to the sea front in Yalta before the return overnight train to Kiev and onwards to Heathrow.

The tour will be on a full board basis, which means that all meals are provided. We will be accompanied by our tour manager Brendan and a translator. Whilst there will be a full programme of activities on offer, there will be opportunities to find free time to explore on your own, if you so wish.

The tour is very reasonably priced at £1050 per person and there will be a single room supplement of £135. For those of us who travelled with FoREM last year Midas offers a loyalty discount of five per cent on the basic price, reducing the tour price to £997.50 (no discount on the single supplement). Travel and medical insurance is available at £75.00 for those over 65 and under 75 on the day of travel.

Included in the price are the following

- Return flights to Kiev from London Heathrow via Prague with Czech airlines and all associated flight taxes and airport charges.
- All coach transportation whilst in Ukraine and all associated costs.
- Return Kiev-Simferpol rail journeys in first class accommodation, two persons sharing a compartment (single compartments are available at extra cost).
- Five nights en-suite accommodation on a shared twin basis in the Hotel Ukraine in Sevastopol.
- Two nights en-suite accommodation on a shared twin bed basis in the Hotel Oreanda in Yalta.
- All meals whilst in the Ukraine (breakfast, lunch and dinner)
- Our tour guide (Richard Rutherford-Moore) and tour manager (Brendan McDonagh) and all their associated costs.
- Two translators and all their associated costs.
- Tour handouts.
- Visa fees and handling (based on a four week turn around – passports required seven weeks prior to departure)

Booking.

Your intention to join this tour must be registered with Midas Tours who will send out booking forms and a request for a non-refundable deposit of £150.00 per person.

Contacts: Alan Rooney, Midas Tours, Chantry House, Common Mead Avenue, Gillingham, Dorset, SP8 4NB., Email. www.info@midastours.co.uk or telephone 01747 825499.

The maximum number on the tour is 30 and there is already much interest, so book early to ensure your place on this exciting trip.

THE INSTITUTION OF ROYAL ENGINEERS.

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

CONTENTS.

PAGE

1. THE CROSSING OF THE PIAVE IN 1918. (*With Photographs and Plates.*) By Major W. A. FitzG. Kerrich, D.S.O., M.C., R.E. 569

2. A WINTER IN WAZIRISTAN. By Brig.-Gen. H. H. Austin, C.B., C.M.G., D.S.O. 585

3. THE HUMAN ELEMENT IN WAR. By Maj.-Gen. C. P. Summerall, Chief of Staff of the Army, U.S.A. 598

4. CROSS-COUNTRY VEHICLES. By Major G. Le Q. Martel, D.S.O., M.C., R.E. 602

5. YACHTING IN KASHMIR. (*With Photographs and Plate.*) By Lieut. M. R. Jefferis, M.C., R.E. 610

6. BATTLE HONOURS OF ROYAL ENGINEER UNITS (*continued*) 615

7. A CONTEMPORARY ACCOUNT OF THE BATTLE OF GUJERAT. (*With Map.*) By the Late Major-General Sir Alexander Cunningham, K.C.I.E., C.S.I. 624

8. A COLONIAL SURVEY SECTION, R.E., IN MALAYA, 1923-26. (*With Photographs and Plate.*) By Capt. S. Woodburn Kirby, O.B.E., M.C., R.E., and Lieut. J. C. T. Willis, R.E. 629

9. ENGINEER TRAINING IN THE TERRITORIAL ARMY. (*With Photographs.*) A Lecture delivered at Chatham on 13th October, 1927, by Colonel E. N. Stockley, D.S.O., Chief Engineer, Western Command .. 650

10. BRIDGING. The Problem of the "Mobile Troops." By Capt. H. A. Baker, M.C., R.E. 658

11. MECHANISATION—A SCHEME FOR THE CONVERSION OF FIRST LINE TRANSPORT. By Brev. Major B. C. Dening, M.C., R.E., *p.s.c.* .. 662

12. SODIUM HYPOCHLORITE AND ITS PREPARATION BY ELECTROLYSIS OF BRINE. (*With Photographs.*) By Major A. P. A. Lewis, R.E. .. 667

13. "FISH, FLESH, OR FOWL?" By Lieut. J. V. Davidson-Houston, R.E. 677

14. WELL-BORING. (*With Diagrams.*) By Lieut. J. B. Gurnhill, R.E. .. 682

15. MEMOIRS. 699
    General Sir Charles Warren, G.C.M.G., K.C.B., F.R.S. (*With Photograph.*)
    Brigadier-General Cooper Penrose, C.B., C.M.G. (*With Photograph.*)

16. BOOKS 714
    Recent Work of the Survey of India. C.F.C.
    History of the Great War. Military Operations, France and Belgium, 1915. Vol. III. (By Br.-General J. E. Edmonds, C.B., C.M.G., R.E. (retd.), *p.s.c.*, and Captain G. C. Wynne, K.O.Y.L.I. H.B.-W.

PAGE

BOOKS—*(continued)*—

A History of the British Army. Vol. XII. (By the Hon. John Fortescue, LL.D., D.LITT.) F.E.G.S.

My Working Life. (By Colonel the Lord Sydenham of Combe, G.C.S.I., G.C.M.G.) Nemo.

Great Captains Unveiled. (By B. H. Liddell Hart.) N.W.N-C.

Field-Marshal Sir Henry Wilson: His Life and Diaries. (By Major-General Sir C. E. Callwell, K.C.B., with preface by Marshal Foch.)

17. MAGAZINES 729

Coast Artillery Journal. D.M.F.H.

Institution of Mechanical Engineers. G.LeQ.M.

Bulletin Belge des Sciences Militaires. W.A.J.O.M.

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The Journal of the United Service Institution of India—July, 1927. P.H.K.

Militärwissenschaftliche Und Technische Mitteilungen. F.A.I.

18. CORRESPONDENCE 751

Popular Handbook on Tides. J. F. Ruthven.

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THE CROSSING OF THE PIAVE IN 1918.

By MAJOR W. A. FITZG. KERRICH, D.S.O., M.C., R.E.

INTRODUCTORY.

IT is hardly necessary in an article published in the Journal of the Corps to point out that no branch of the art of military engineering is of greater importance than bridging. It is, as we all know, not an overstatement to say that there are occasions when the success or failure of a bridging operation in war means the success or failure of operations as a whole.

While officers of other branches of the Army can rest content with a general knowledge of the subject, we, whose duty it is to provide the bridges, cannot afford to miss any opportunity of mastering the details. Especially is this the case as regards the stock bridges on which we mainly rely—the assault bridge, the pontoon bridge, and the box girder bridge; of which three types the pontoon bridge presents the greatest difficulties and is the one whose employment demands the most careful study. The assault bridge is of simple design and simple to handle, and "it will normally be the duty of the assaulting troops to carry and launch it". (*Engineer Training, Vol. II*). The problems in connection with the box girder bridge are mainly those that any engineer has to face when erecting any girder bridge.

The classic examples of pontooning during the Great War were, of course, the bridges erected in the Mesopotamian Campaign. Those concerned have described their experiences; and since the appearance of the *Official History of the Mesopotamian Campaign* there can be few R.E. Officers who have not made a study of the bridging operations in that country, and in particular the crossing of the Tigris at the Shumran Bend in February 1917.

On the other hand, so far as I am aware, only two accounts have ever been written of the bridges erected in connection with the fighting that resulted in the collapse of Austria, and these accounts are contained in books* not readily accessible to the average R.E. officer. Yet in point of fact the pontoon bridge over the Piave had the greatest overall length of any bridge erected during the war, while some of the problems in connection with it, both tactical and technical, are well worthy of study by every R.E. officer.

*"The Defeat of Austria, as seen by the 7th Division," by the Rev. E. C. Crosse, D.S.O., M.C., published by H. F. W. Deane & Sons, 1919 and "The 7th Division," by C. T. Atkinson, published by John Murray, 1927. I wish to make full acknowledgment to these two authors for a good deal of the subject matter of this article.

As in the nine years that have intervened since the bridge was built none of the other R.E. officers concerned have come forward with an account of what took place, I will make the attempt myself; for it would be the very greatest pity if some of the lessons brought out were buried in oblivion. I must apologise for the personal note in the account that follows, but I was so intimately connected with the affair that it would really be useless for me to attempt the rôle of disinterested spectator. I have therefore made no effort to do so; but have put in a good deal about my personal reactions to the situation, for the benefit of anyone who may ever find himself similarly circumstanced.

GENERAL REMARKS.

The 7th Division came to Italy at the end of 1917, when the Austrians broke the Italian front. The Italian retreat ended at the River Piave; and at the end of December the division was allotted a sector of the river front called the Montello Sector, after a large hill that stood up there in the middle of the surrounding plain. It was there about two months in all, but unfortunately for me I was at home in England doing a course, and did not see the river. The division was then transferred to the Asiago Plateau, where I rejoined it; and there it remained, with the exception of periodic intervals of rest down on the plains below, until the operation we are considering took place. Work on the Asiago Plateau consisted of hutting, excavating trenches and dug-outs in the rocky soil, wiring, screening roads, etc., etc. One saw a good deal of the famous Italian aerial ropeways; and if the thought of bridging ever crossed one's mind it took the form of a suspension or girder bridge over a ravine.

When, therefore, having been recalled from leave in Rome and made C.R.E. of the division on October 16th, I saw the Piave for the first time on the 19th, I was about as unprepared for the operations that started on the 23rd as it was humanly possible to be.

I stress this point on the grounds that the moral is four times as important as the physical in war. Doubtless the majority of R.E. officers were able to retain their sense of proportion throughout four years of trench warfare, and were fully prepared when it came for their first bridging operation in the face of the enemy. I cannot help thinking, however, that I was not quite alone in regarding my pontoon wagons as invaluable, and the bridging equipment that they were supposed to carry as a bit of a white elephant.

Though the fact that the Piave would have to be crossed had been obvious to the meanest intelligence for the past two months, during which time the division had been at rest on the plains, I had never reconnoitred the Piave, never gone to see what equipment the Italians had for bridging, and did not even know how many British pontoons were available in the country.

Even the fact that when in June, 1918, the Austrians made a strong but unsuccessful attack across the Piave, the river rose behind them and broke their bridges, had made no mental impression on me.

Pontooning it is true had been practised when resting out of the line, but not in a river flowing any faster than the Medway.

STRATEGIC SITUATION. SEE MAP 1.

On October 6th Lord Cavan took over command of the Italian Tenth Army, consisting of the British XIV Corps, 7th and 23rd Divisions, and the Italian XI Corps. About this time presumably the preparations shown on Map 1 for the grand assault on the Austrian position were matured.

7th Div. R.E. Situation.

Blissfully ignorant of this, however, I applied for and obtained a fortnight's leave to visit Rome, only to be recalled in a week's time to find that the C.R.E. 7th Division, Lieut.-Col. E. Barnardiston, had gone to be C.E. XIV Corps, and that I was appointed C.R.E. in his place. P. K. Boulnois left his job of S.O., R.E., to come and command the 54th Field Company in my place. These changes, dating from October 16th, naturally caused considerable confusion, which was intensified by the fact that C. P. Gibson (temporary) O.C. 528th (Durham) Field Company, and A. H. Fletcher (temporary) the Adjutant, were also both absent. I forget now whether they were on home leave or were stricken down by the prevailing influenza epidemic.

The Piave.

On October 19th, with a party of officers I reconnoitred the Piave in the neighbourhood of the little village of Salettuol. (See *Map* 2). We were dressed in Italian helmets and greatcoats, so as not to give away the fact that British troops were going to take over the sector. (Secrecy in this respect was carried so far that the operations of the bridgehead assault party were supported solely by Italian artillery.)

The sight that met our eyes was not an encouraging one. The following description is lifted bodily from C. L. Atkinson's "7th Division."

"The 7th Division had met the Piave already and had found it a formidable obstacle. Here it was even wider than on the Montello front, and at Salettuol, in the middle of the division's line, it was nearly 2,500 yards from bank to bank, though a large island, the Grave di Papadopoli, occupied part of the intervening space. This island, about three miles in length and over a mile wide at its broadest, was the largest of the many shoals and islands in the river bed, separated by channels sometimes fordable, sometimes quite deep, through which the stream ran extremely rapidly, as fast as eight miles an hour.

What doubled the hazards of the crossing was the fact that the incessant and excessive rains had swollen the river into a high flood, submerging completely the tops of the shoals which usually gave some idea where the channels ran. All that could be seen was the tops of some trees on the Grave, which over that expanse of raging waters looked miles away."

The only criticism of this excellent description that I have to make is that in my opinion 8 miles an hour is a conservative estimate. I thought at the time that 10 miles an hour was nearer the mark, but possibly the waves breaking in all directions gave an unduly high impression of the speed of the current.

In any case it was a formidable task. Some of the more important questions that required an answer were :—

i. What were the chances of ferrying troops across.
ii. How were we to get our anchors out for the bridge.
iii. Would the anchors hold in the stony bottom, and, if they did, would the pontoons ride the flood.

The aeroplane photographs give a very good impression of the conditions of the river. As the dates on them show, they were taken on October 22nd, though, unfortunately, they did not come into my possession till after the bridge was built. The point from which the bridge started is marked " A " on both photographs, which are two successive views of the ground in the vicinity of the village of Salettuol. (See *Map* 2). The little dark square on the water at " A " is the shadow of a hut. It will be noted that the details of the river bed on the map are sketchy and inaccurate; and it was one of the difficulties of the situation to know for certain where the main river channels were at any given moment.

THE ITALIAN PONTIERI.

I must now introduce you to the chief actor in the play.—Captain Odoni of the Italian Pontieri. I met him about this time. He commanded a pontoon company and had been in the sector for some time past with his men studying the situation. He knew no English and I no Italian, and it took several interviews to elicit the information out of him given below. I would have given a good deal then to have been able to speak Italian.

He said that he was fully prepared both to ferry troops across and to build a bridge. He knew the river thoroughly, though of course it changed a good deal from day to day. He was fully prepared to function even when the river was in flood, for his men were specially enlisted from the seafaring population and had been specially trained for the work. He had specially built flat-bottomed boats for ferrying, and could also build foot-bridges with them. His anchors and pontoons, the latter open and made of steel, were specially designed for such conditions as were now prevailing. To get his anchors

out he would put his pontoons into the water well upstream and drop down, not attempting to row the pontoon, but guiding it from side to side of the river by setting it at an angle to the current as required.

Naturally I was not the only British officer who had to digest this information. To mention but two, there were the G.O.C. 7th Division and the Chief Engineer of the Corps. The ferrying operation took place on the 23rd, so that there was not much time in which to pump Odoni, and to come to a decision as to whether he was likely to be capable of fulfilling his promises. I attended a considerable number of conferences myself, and Odoni must have attended a good many more than I did, all of them necessarily very protracted as everything said had to be translated by an interpreter. Judging from his looks, we very nearly wore him completely out with those conferences; and I do not know how he ever found time to make all the necessary preparations.

As an instance of how diverse two points of view can be, I may give the following instance of what occurred at one of these conferences. I was explaining to a distinguished "Q" staff officer some of the difficulties that would have to be overcome before the bridge could be built, when he interrupted me saying "I see that you have not grasped the point at all. The fact is that one bridge is perfectly useless: with the traffic of at least two, and most probably more, Corps to cope with, two bridges are the absolute minimum necessary to meet our requirements"!

The conferences brought out one very important point, namely, that the whole of a Pontieri company is not composed of skilled boatmen; but that the number is somewhat limited, the bulk of the company being unskilled men, or at any rate unskilled boatmen.

Also there did not seem to be enough Italian pontoons to cross the river from dry land to dry land, but only enough to bridge the deepest parts.

Scheme.

As the situation gradually clarified a plan of action emerged. The first decision come to was to trust Odoni. As I held out no hope of being able to ferry the bridgehead party across with my own men, it was really a question of Hobson's choice for those responsible for making the decision. There was no chance of fording the river: the Italians were quite convinced on this point, and R. D. B. Perrott, who spent a couple of nights on the river with some of them, confirmed their statement. He was able to reach Veneto Island by punting across in one of their ferry boats, but found the main current running on the far side. Hasty attempts were made to rub up our knowledge of pontooning in the river running through Treviso, a deep and narrow stream running about four miles per

hour, in no way to be compared with the Piave River; but I do not think that any Field Company officer in the division thought that there was any chance under the conditions then prevailing of a pontoon crossing the Piave in spate, with its fierce and intricate currents and its dangerous shoals.

Odoni therefore was to do the ferrying. Whether given time the Sappers could have been trained to the task is a moot point. Personally I rather doubt whether anyone not used to boats all his life could gain the necessary skill, and in any case intensive training over a long period would be necessary. Anyone who wishes to make the experiment must be prepared to face a high percentage of wastage, both of materials and men.

The second decision was that the 7th Division R.E. must make all preparations for building a pontoon bridge, when the assaulting troops had captured the Island of Papadopoli. Assistance from the Italians was not entirely ruled out of the picture; but ferrying was to be their main occupation, and they were only to be used for bridging if they were not required for ferrying.

The site of the bridge was selected at a place where the main current, after coming down outside Veneto Island, ran right inshore (See *Map* 2, and the aeroplane photographs). A small shoal was just visible about 120 feet away on the far side of the main current. The photographs show this clearly. Once landed on the shoal there was a good chance that the rest of the river would prove to be fordable; though of course this was only a hope and not a certainty.

The only suggestion that anyone could make for getting the anchors out was to cross to Veneto Island over the subsidiary stream dividing it from the mainland, and plant the anchors in the ground at the foot of the island. The pontoons were also to be taken across to Veneto Island and let down to the site of the bridge on long cables.

A further advantage of the site chosen was that a moderately good road led down, from Maserada and the main road system in rear, to within 300 yards of the site, when it turned to the left and became a rough track. (What appear in many places on the aeroplane photographs to be roads running roughly parallel to the river will be seen on closer inspection to be embankments, built to restrain the floods, and used as breastworks by the Italians).

Ferrying.

It was decided that the 22nd Infantry Brigade should be ferried across and capture the Island of Papadopoli. The crossing place chosen was from the island of Cosenza, to which there was already a footbridge over a minor branch of the river, to the extreme N.W. corner of the Island of Papadopoli—known as the Lido. *Map* 2 explains the general idea of the operation. A very full account is

contained in "The Defeat of Austria" for those interested in the tactical details, but I will confine myself to the ferrying operations. Odoni had provided twelve of his flat-bottomed boats with two ferrymen each on Cosenza Island and was in entire charge of the ferrying operation. It was a moonlight night but cloudy, and "at about 7 p.m. the first boat, with a crew of seven exclusive of the ferrymen, set out to reconnoitre the crossing. They returned in twenty minutes, having done so, and reported as follows:—There were three main streams to be crossed separated by two shoals of sand. The first stream was about 70 yards across and unfordable; the second was about 50 yards across, and contained the swiftest current. This was also unfordable, which meant dragging the boat round the edge of the first shoal, about 15 yards in breadth. The third stream was about 100 yards across. Here the current was slower, and as the water was only about two feet deep, this part could be forded. There was nothing to suggest that the enemy had detected the crossing.

There were 800 men to be taken over, and the first two platoons started across at about 8 p.m. Two boats were swept downstream, and though they eventually landed somewhere on our bank of the river, it was a long time before they were available again. The remainder, carrying about 80 infantry, crossed successfully and swept forward about 300 yards, surprising several Austrian posts. The alarm was given, the Austrian barrage came down, and their machine guns opened up. At the same time the moon broke through the clouds. In spite of this, however, three companies were ferried across with surprisingly few casualties; and by 11 p.m. were formed up on the starting line for their advance S.E. down the island.

A thick mist descended about the time the attack started, which, if it hampered the attack at all, certainly helped the supports to cross.

The attack reached a line opposite Salettuol, as shown on *Map* 2, by dawn on the 24th.

On the 24th a steady rain fell, causing the river to rise and making the ferrying of reinforcements and supplies a slow and difficult business. One ferryboat was capsized in midstream; and all this time the ferry was within bullet range of the Austrians on the mainland to the left. Consequently there were a considerable number of casualties. At night the Austrians used searchlights to assist their fire.

On the night 25th-26th we renewed the attack, and at dawn on the 26th the Austrians made a final and unsuccessful counter-attack. When this had been beaten off the whole island was in our hands.

Perrott, who had crossed by the ferry the night before to gain information, got hold of a lifebelt, and with its aid swam back in the morning, landing on Veneto Island.

THE BRIDGE.

The general plan of operations was that when the Island of Papadopoli had been captured by the 22nd Infantry Brigade, the main attack on the mainland should be made by the other two brigades, the 20th and the 91st. When it was decided that the 22nd Infantry Brigade should make their final effort on the night 25th-26th, assuming that it would be successful, the question arose by what means the other two brigades were to cross to the Island to carry out the main attack. It had been ascertained that the branch of the river on the far side of the Island was just fordable, so for the moment the question of ferrying or bridging operations there did not arise. The natural answer was that the main bridge should be started in time to get the other two brigades over. The ferry at the Lido was only able to cope with the necessary work in connection with one brigade, and everyone was agreed that the task of taking two more brigades over was quite beyond its capacity. The work it could do depended not on the number of boats available but on the limited number of skilled boatmen that Odoni had at his disposal.

The disadvantage about starting the main bridge while the Austrians still held the far bank of the Piave was that they were only 2,500 yards away, were naturally expecting a bridge to be built, and would do their utmost to destroy it when started. This argument was still stronger on the 25th, when the Austrians held part of the Island of Papadopoli.

A long conference was held on the evening of the 25th which Odoni and I attended. The decision taken was to assume the success of the operations that were to take place that night for the purpose of clearing the Austrians off Papadopoli Island and to start the bridge at Salettuol that night.

Now that it was proved up to the hilt how efficient the Pontieri were, we were all naturally anxious that they should build the bridge, or at any rate the first part over the main current. The claims of our troops already on the Island were too strong, however, and the final decision taken was that the ferry must be maintained for their benefit, and that the 7th Divisional R.E. must build the bridge. I consequently issued orders to that effect after the conference.

On the night 23rd-24th the 54th Field Company had made what preliminary arrangements were possible to this end, and had put down twelve kedged anchors in the shoals at the foot of Veneto Island directly above the site of the proposed bridge. From these the pontoons were to be let down on long cables.

The work was hard and dangerous. The first thing necessary was to get a cable across to the island. A sergeant and four men took the running end of the cable on board a borrowed Italian boat. Two men were to punt, one to steer and one to pay out on the cable.

Immediately they set out they were at once swept downstream completely out of control and the boat started to fill with water. Their luck was in, however, for on coming to the end of the rope, which was about 250 yards long, and taking soundings, they found that it was just shallow enough for them to get out, and that they had reached the island. With a cable across the rest was comparatively easy, though the Austrian barrage due to our attack on the Lido made things very unpleasant.

My orders issued on the evening of the 25th were therefore to make the attempt to bridge by lowering pontoons down from these anchorages on Veneto Island.

By one of those chances so frequent in war, Odoni's instructions to his company miscarried, and one of his officers started to bridge with Italian pontoons at the Salettuol site. Before he received orders to stop work and continue to ferry at the Cosenza—Lido crossing he had put four pontoons into bridge. The news reached me some time in the middle of the night and I set out for Salettuol, reaching it at dawn.

The shoal we were aiming for was still about fifty feet away and the water over four feet deep and running like fury. I ordered a man overboard with a rope round him, but naturally enough it was impossible for him to stand up, his legs were swept away from under him at once. I then said that an effort must be made to get a Weldon trestle into the water. As we were going to join on to Italian equipment the joint was bound to be an improvised one in any case, and there was therefore no need to get the trestle the regulation fifteen feet (old equipment) away from the pontoon saddle. I then went over to look at the situation on Veneto Island.

Returning, I found that a trestle had been got into position, and that therefore the bridge to the first shoal could be completed with trestles, and that there was no need to experiment with pontoons let down from Veneto.

It was an exciting moment when Boulnois, E. H. M. Clifford, O.C. 95th Field Company, and I, armed with alpenstocks, crossed to the shoal and set out to solve the burning question of the moment. What we wanted to know, of course, was whether or not the rest of the crossing was fordable, with the necessary corollary that anchors could be put out by hand. If it were not so, and another deep channel had to be crossed, how was it to be done?

Fortunately we did not have to provide the answer to this question, since we found the crossing feasible.

Hurrying back I put through a call to Division, gave them the glad news, and begged them to do everything possible to keep enemy aeroplanes off. By another of those bits of good luck that were so plentiful at this time, it was a very misty morning, and we

were totally invisible to Austrian ground observers, my only fear being that the enemy's aeroplanes might discover us.

Work now commenced in earnest. Pontoons had to be got up, the river bank cut through, and the wagons driven across to the first shoal to start the bridge again from there. At about this time the river was at its maximum, and from then onwards slowly fell. A ford had to be marked out for numerous people of every description who now wanted to cross.

The road from Salattuol cross roads had to be made good. Fortunately this was not a very difficult operation, since in that soil you only had to dig down a few inches to come on a bed of rounded stone, soft enough to crush and bind into a reasonably good road surface. At one time we had our own Pioneer Battalion and a battalion of Italian infantry working on this. It took a little time to explain to the latter what was wanted, as no interpreter was available; but they were a willing enough crowd when they had grasped what our requirements were.

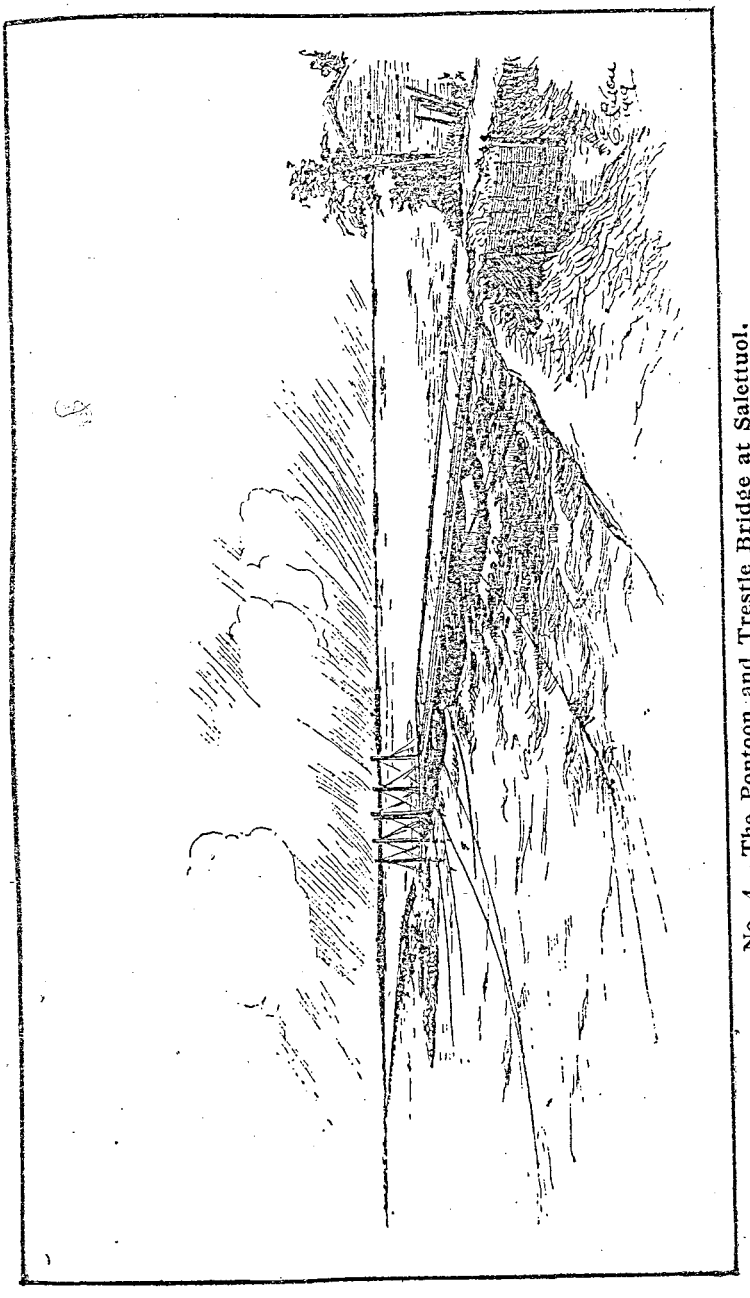
Division were insistent that the two brigades that were to cross that night should get over dryshod, in view of the fact that they had a battle to fight at dawn next day. On the other hand the construction of the bridge was a slow business. The nature of the stream, its strength and the numerous shoals, all slowed up the work and made it very exhausting. Labour was plentiful, however, as Brig.-General Barnardiston, the Chief Engineer, had loaned me a field company from the 23rd Division under M. Luby, and an Army Troops company.

Doubtless a more experienced C.R.E. would have handled these masses of men to better advantage; but, as things were, it became certain after a time that the pontoon bridge could not be completed that night. No sooner had this fact become apparent than a complete set of wooden trestles and duckboards for a light bridge for infantry in single file appeared, under the charge of G. G. MacD. Carr-Harris, then acting as adjutant. These were the gift of Brig.-General Barnardiston, who had found them somewhere and sent them along to save the situation.

These were put in position by Howett (temporary) on the far side of the crossing, where there was some rather boggy ground with bushes growing in it—the darkish portion of the crossing in the aeroplane photographs. (See *Key* to No. 1).

When night fell on the 26th, therefore, there was a continuous bridge for infantry the whole way across, except where a shoal stuck its back out of the water here and there. Half of it consisted of pontoons and the other half of light trestle bridge. This latter was a portable trestle with splayed legs, transom ledger and diagonal. One of the legs stuck up beyond the transom to take a handrail.

The 20th and 91st Infantry Brigades crossed the bridge without



No. 4.—The Pontoon and Trestle Bridge at Salettuol.

incident that night and made their successful attack on the mainland at dawn. It naturally took a very long time for that number of men to cross in single file.

Next day, October 27th, work started again at dawn, and the complete pontoon bridge was finished shortly after midday. The final stages were somewhat delayed by the G.S.O.1 of the division, who insisted on escorting a large and straggling herd of ammunition mules over it before it was done. No doubt he was quite right when he said that however necessary the bridge was it couldn't compare with the ammunition in importance; but the officer whom I had put in charge of the bridgehead building operations throughout nearly burst a bloodvessel. This was one Matheson, a temporary officer, who had spent his life engineering and fighting in South or Central America, had been a Corps Field Engineer, and had been lent me for the occasion as having more experience of rough-and-ready bridging than most. I had to lead him away while the mules went over, and let him relieve his feelings in Spanish before I could get him to resume work.

When completed the overall length of the bridge was, I should say, a trifle over 500 yards. We used up nearly the whole of two pontoon trains, which according to the 1914 *Field Service Pocket Book* carried 1,500 foot run of bridge. This figure tallies pretty closely with measurements from maps and the aeroplane photographs. Where shoals stuck right out we laid fascines on the sand.

It is fortunate that the attack on the morning of the 27th was successful, as the day was fine and the enemy spotted the bridge. Being very busy, however, he did not start to shell the bridge until the afternoon, and could then only bring long range fire to bear. This, while of heavy calibre and unpleasant, was not quite accurate enough, and no direct hits were registered on the bridge, though traffic was considerably disorganized.

When completed the personnel and transport of a considerable portion of the Italian Army started to use it. Besides the guns and transport of the two* British Divisions, there was the rest of the Italian 10th Army.

In addition, since the Italian Corps opposite the Montello had not reached their objective, they were also sent over our bridge to strike up in a northerly direction. The A.P.M. of the 7th Division with 100 men took on the task of regulating this traffic. At the bridge each wagon was given one chance and one only; if the animals baulked they were hauled off and told to get away out of it. Some

*The 23rd Divisional Infantry crossed by means of a footbridge at the Cosenza-Lido crossing. By whom or when this was constructed I have no information. *Photo. No.* 6 shows the completed article. It is to be hoped that some of those concerned will come forward with information about it, and also about the bridges at Sacile and over the Meduna east of Pordonone, constructed by the 23rd Division. (*Photo.* 7).

amusing scenes with protesting drivers and their officers were witnessed.

The roads behind were congested for miles back, and the rate of progress at one time fell to one mile in six hours.

Those waiting bivouacked on and off the road, and suffered very heavy casualties from Austrian bombing planes.

On the night 27th-28th we had our first stroke of bad luck. The river had been falling, and as a result the main stream, instead of coming down at right angles to the bridge, had altered direction and now hit the Italian pontoons at an angle. The joint between their equipment and ours had always been a source of anxiety of course; and now in addition the scour of the river was undermining the trestle legs. As was the pleasing custom of the old type of trestle the transom jammed as soon as it got any excuse to do so, and two differential tackles on each leg failed to shift it.

Finally the water began to wash over the bridge and it became obvious that a break must occur. Everything possible was done in the darkness to put the matter right, but with no success, and eventually the bridge broke.

The Pontieri were sent for; but pending their arrival we tried to mend the bridge ourselves. Most unfortunately, when the trestle gave, two of the pontoons had also been torn away from their moorings, and it was therefore not possible to put trestles in again. In consequence we had to fall back on our original plan of letting down pontoons from Veneto Island. Several attempts were made but it was not found possible to get the pontoons to go where they were wanted; for they swayed about on the ends of their cables and threatened to foul the two pontoons that were still in bridge and their anchor cables. Finally, when one pontoon was capsized and the men in her drowned, we gave up the attempt. Some more long range shelling added to the gloom.

On arrival the Pontieri showed us what child's play it was for two men to jump into a large steel pontoon upstream and guide it into any required position. They do not even row, for one man sticks an oar over the side, paddle fashion, standing up in the bow, and the other does ditto over the other side in the stern.

Soon the bridge was in working order, and so it remained till the campaign was over and we re-crossed it about November 10th. The river had shrunk to its usual size then, and the sight of several hundred yards of pontoon bridge firmly seated on the ground was an unusual and rather comic sight.

A cursory inspection showed no signs of wear, though, doubtless, had the river risen again some of the pontoons would not have risen with it. After various divisions had passed over it they were

kept supplied by 30-cwt. lorries passing over the bridge; for no railway bridge could be constructed in that short time over such a wide river. The Italians believed in loading their vehicles to their full capacity, and the fact that the bridge stood the strain reflects great credit on the designers of the old boats. I believe that a few 3-ton lorries got over as well, though I cannot vouch for this.

ADVANCE ON THE TAGLIAMENTO.

A few notes may also be of interest on the advance to the River Tagliamento, which was reached on November 3rd, the day before the armistice was signed. (See *Map* 1). The route was via Sacile and Pordenone and the distance about 65 miles. Such a rapid advante was of course only possible in view of the fact that the Austrians, once their front on the Piave had been broken, made no further serious resistance.

I was relieved of my job as O.C. Piave Bridge on October 28th, and told to rejoin my division on ahead. I was only allowed to take one field company—the 54th—with me, as the others were required for maintenance and bridging on the far side of the Island of Papadopoli.

Having one of the few cars that managed to cross the Piave at my disposal, I was able to do a good deal of reconnaissance myself. On October 30th I arrived at the River Montecano (a small stream between the Piave and the Livenza, not shown on Map 1.) to find that the infantry had forced a passage, and that the bridge was undamaged. It was, however, fully prepared for demolition, and, but for a small mistake on the part of the Austrian R.E., would probably have been destroyed. The river banks were very high, and afforded complete protection from bullets fired from the opposite side of the river. The charge was to have been fired electrically, and, had the leads been carried over the bank, the man detailed for the job would had had plenty of time at his disposal, as the Austrians made a stand lasting some time at this point. Actually the leads were very short and ended at the abutments, and the moment our troops lined our bank it was risking almost certain death to fire the charge.

The next river was the Livenza. I struck this on the afternoon of November 1st, at a point a few miles below Sacile called Cavolano. Here there was a timber bridge which had been destroyed, but could be quickly repaired for foot traffic. There was no enemy opposition, and the 54th Company started to work and made the bridge fit for infantry in single file. Proceeding up to Sacile I saw that the railway bridge south of the town had been very thoroughly destroyed. The enemy were sniping from the opposite bank, so I did not investi-

gate very closely, merely making a mental note that the wreckage was of no use to me. It was dusk and I did not get a very clear look at it. In Sacile the Austrians had abandoned a huge dump containing stores of every description, including a pontoon park. As Division were calling for a pontoon bridge at Cavolano I made arrangements to have enough of these Austrian pontoons carted down there, since none of our own were immediately available. While we were still struggling in the dark to find out how their equipment fitted together, enough of our own arrived from the rear—sent up by G.S.O.1.—to do the job.

The river was about 200 feet wide, I should say, and was not running impossibly fast, and the bridge was completed in time for the infantry to cross in the morning. Visiting Sacile again that morning, great was my chagrin to discover the 23rd Divisional R.E. hard at work repairing a timber bridge alongside the railway bridge that I had reconnoitred the evening before. Though slightly burnt this trestle bridge only required a few minor repairs to make it fit for any kind of traffic, and I had completely overlooked it!

This day I got orders to repair a bridge over the Meduna East of Pordenone. Visiting it by car, I found a railway and a road bridge, both partially destroyed. (See *Photo No.* 7.)

I had only one company available, and they were a long way off, and no materials. After trying to make arrangements for bringing up some Austrian pontoons next day from Sacile, and feeling somewhat harassed, I found a comfortable billet and went to sleep. About midnight I was woken up by R. A. Turner of the 23rd Divisional R.E. and informed that this was his bridge, and that on no account was I to touch it. I gracefully conceded the point.

Next day, November 3rd, I crossed the Meduna further to the north, where it had dried up in its many beds, and reached the Tagliamento. All the field companies came along too, the 95th and 528th arriving by forced marches from the Piave. The enemy, who were on the opposite bank of the Tagliamento in overwhelmingly superior numbers, declared that peace had been signed; but refused to let us cross in force. The long timber road bridge over the river at this point, Gradisca, had been destroyed; but the river was fordable. Sufficient of the bridge still remained unburnt to supply materials for bridging over the actual waterways; and this would have been our next task had not the war finished next day.

It would have been a rather slow job, and no more pontoons were available; but "Q" said that there was no need to worry as we were at the absolute limit of supply by road, i.e. 60 to 70 miles, and that no railway bridge was being built over the Piave.

Conclusion.

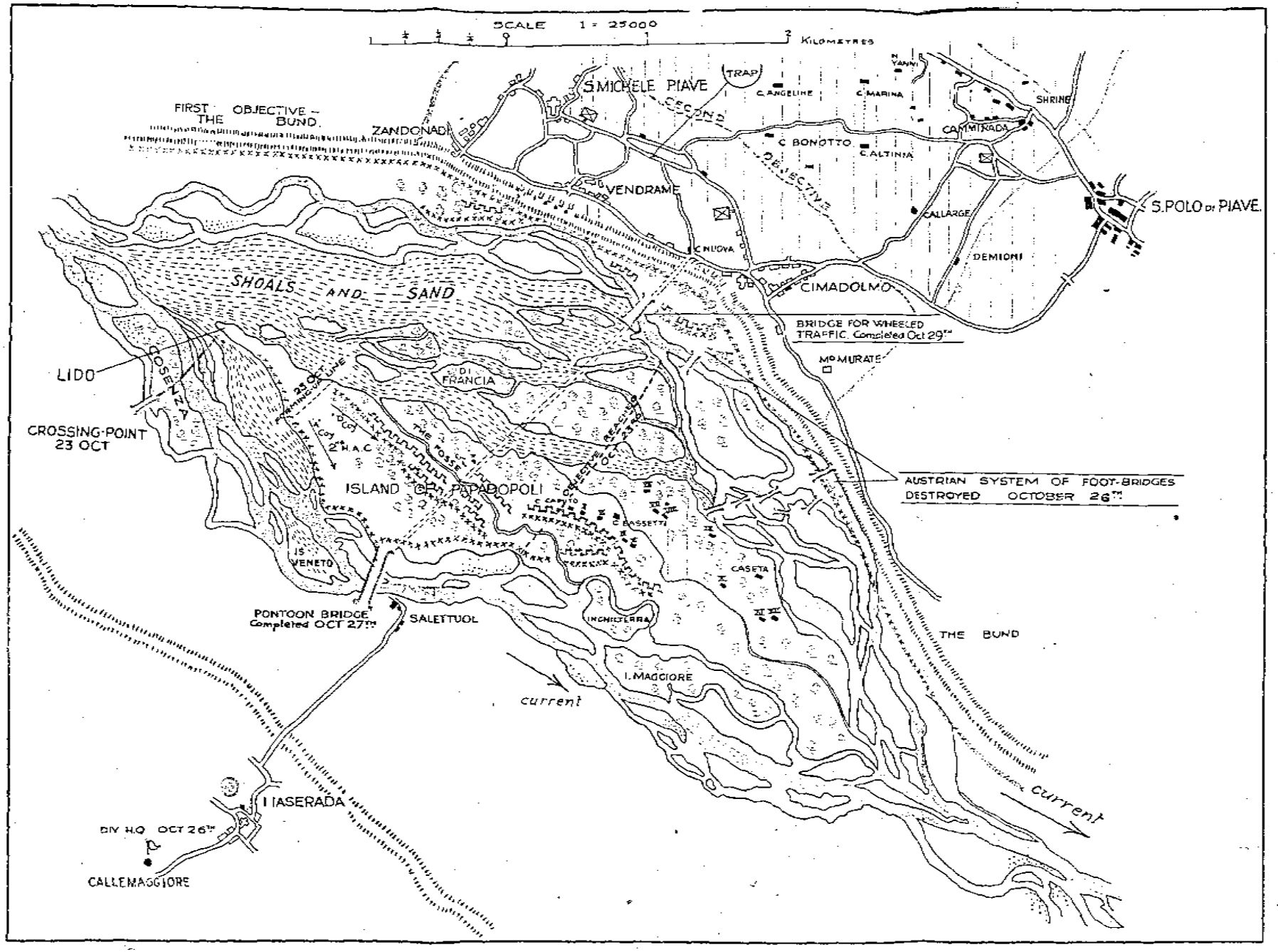
May I, in conclusion, emphasize three points arising out of my experiences?

(i). All R.E. work is useful, but only some of it can be classed as of vital importance. The R.E. Officer must look ahead and make all necessary preparations, both mental and material, against the day when he may be called on to carry out a task of the latter type. It is hard to think about bridging when the whole world is clamouring for huts or horse standings; but it is essential to do so.

(ii). A big front line bridge presupposes a bridgehead. As much thought and time should be devoted in practice by us to assault bridging and ferrying as to pontooning. The question of the right time for ferrying operations requires the most careful study.

(iii). Pontoon bridges are kept in position by anchors. Many rivers flow too fast for rowboats to perform the task of putting them out, and I therefore advocate the provision of a suitable motor boat with every bridging train.

MAP 2.—THE PIAVE CROSSING, showing the Grave or Island of Papadopoli, the site of the Pontoon Bridge at Salettuol, just below Veneto Island, and the Cosenza-Lido Crossing where the assault party were ferried over.

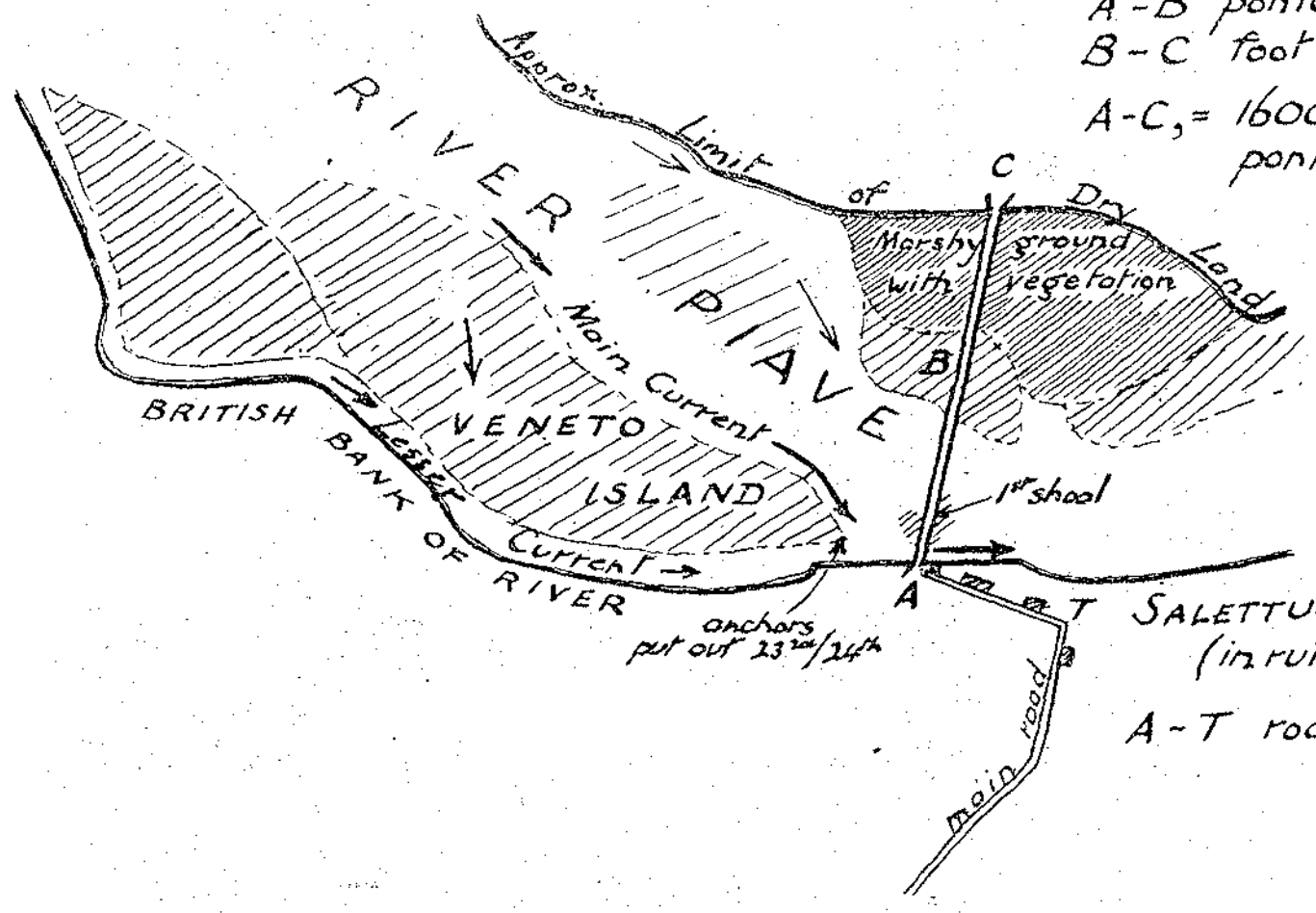


KEY TO AEROPLANE PHOTO No. 1.

ISLAND OF PAPADOPOLI.

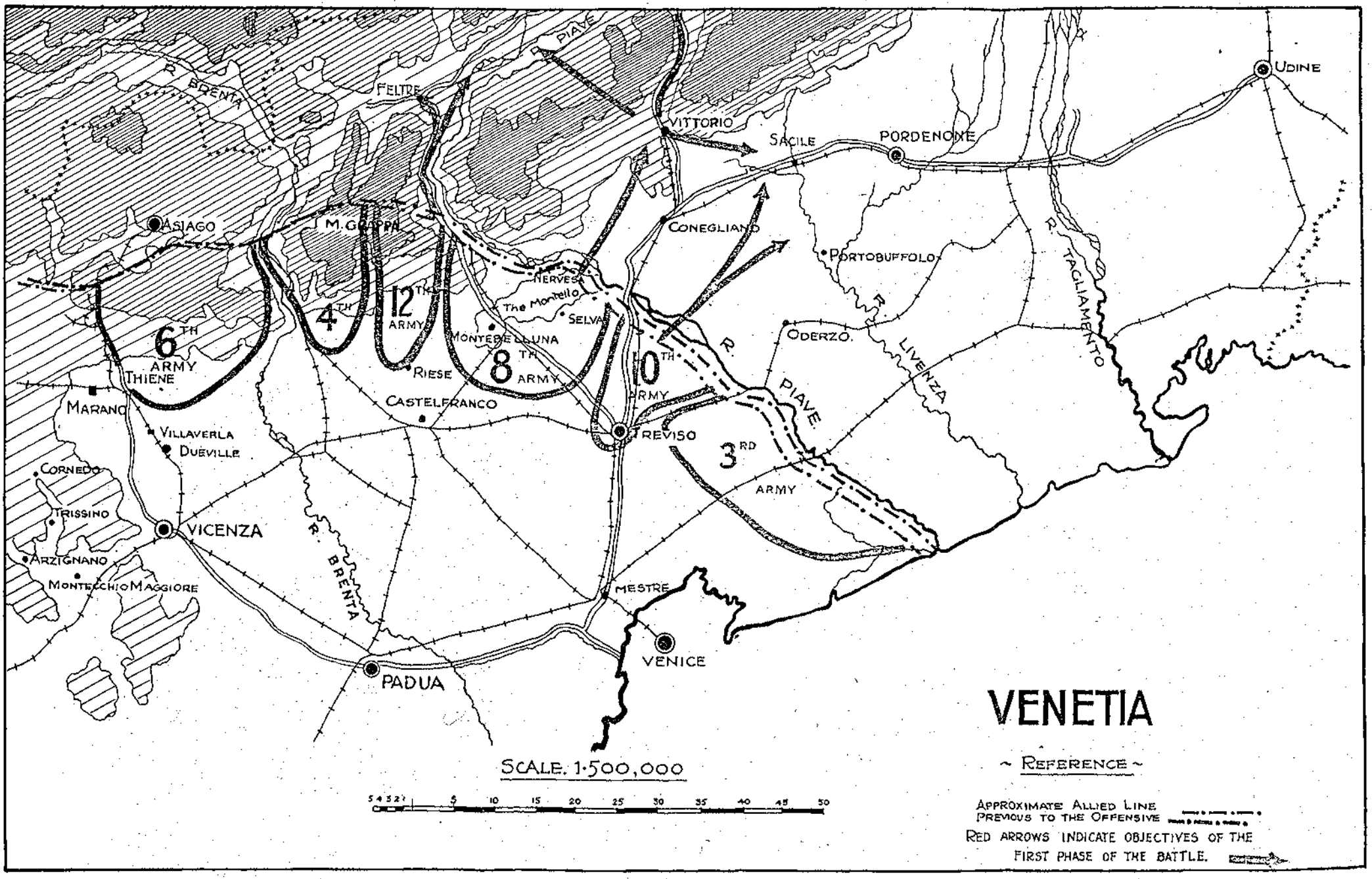
A-B pontoons } on 26th Oct.
B-C foot bridge }

A-C, = 1600 feet appr; pontoons on 27th Oct.



A-T road made good

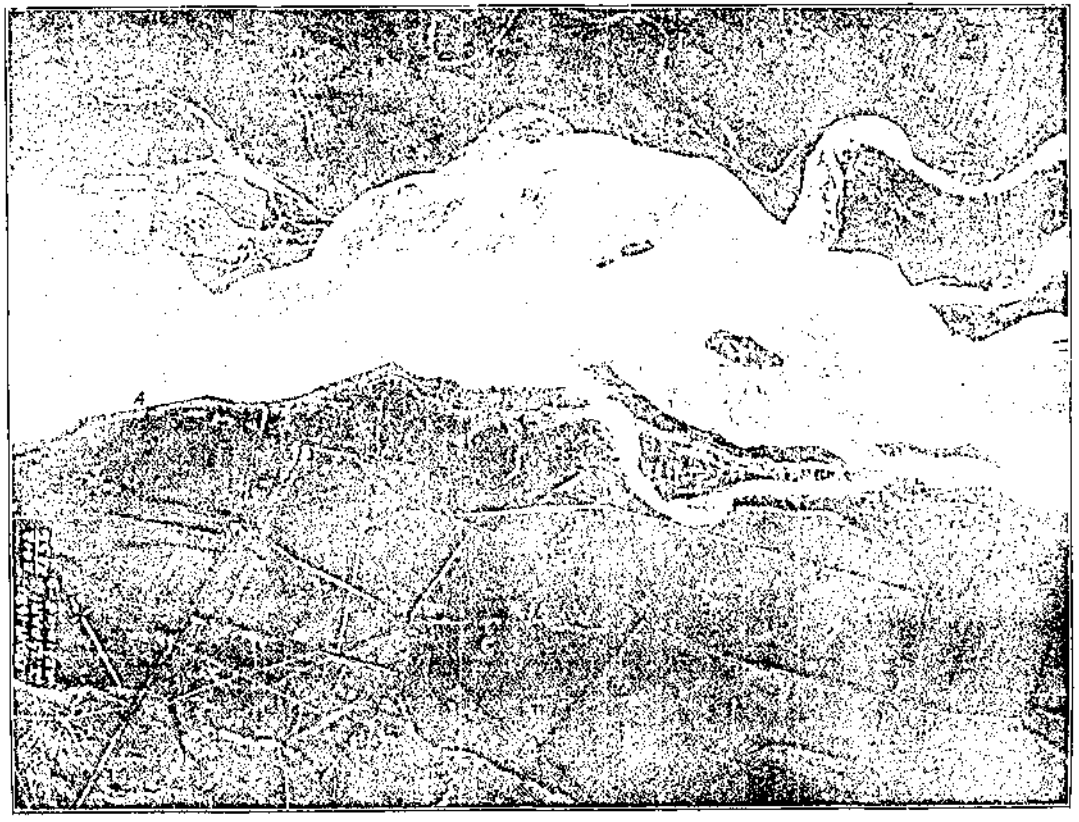
MAP 1.—The Strategic Situation.



THE CROSSING OF THE PIAVE IN 1918.

No. 1.—Aeroplane Photograph of River Piave.

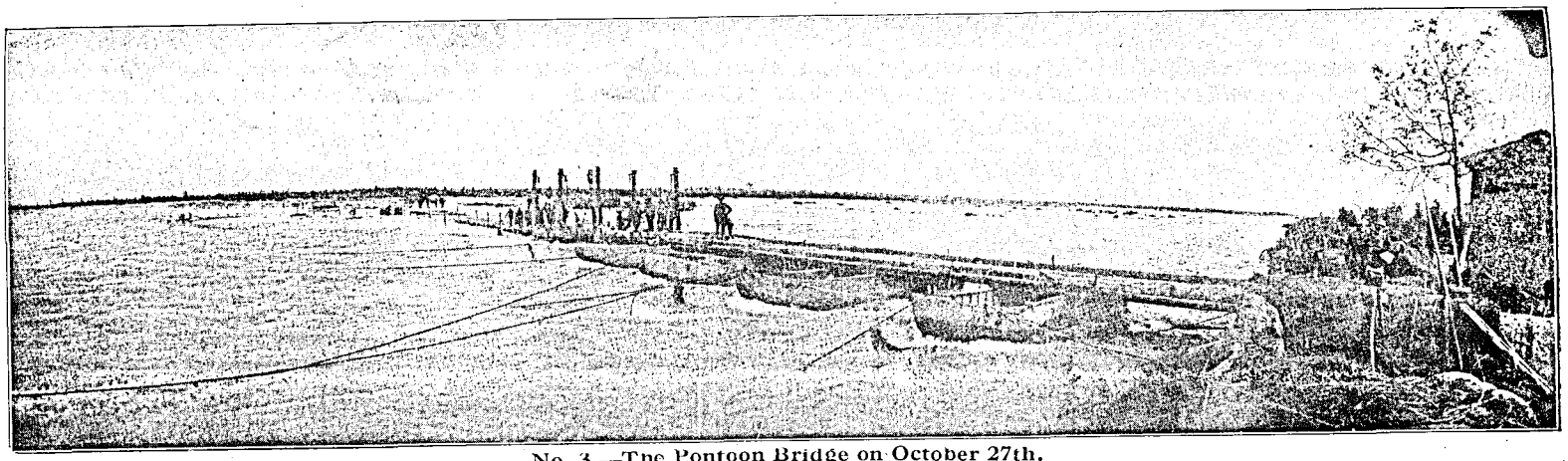
The Pontoon Bridge started from point marked A. River flows from left to right, i.e., N.W. to S.E.



No. 2 —Aeroplane Photograph of River Piave.

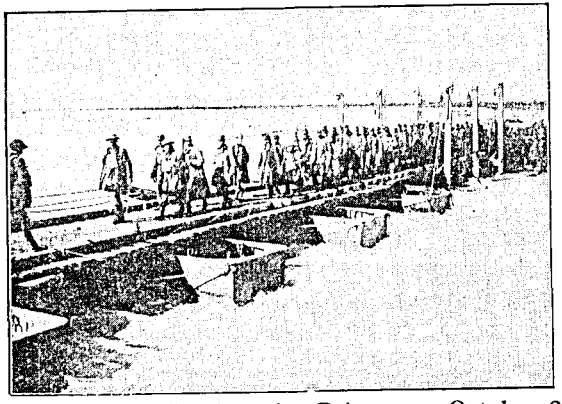
Taken from a point downstream of No. 1 photograph. Bridge started from point A.

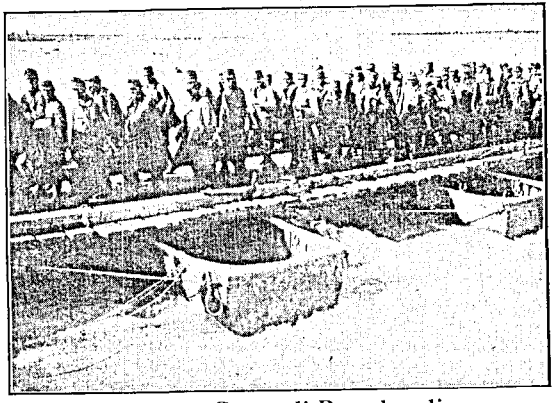
THE CROSSING OF THE PIAVE IN 1918.



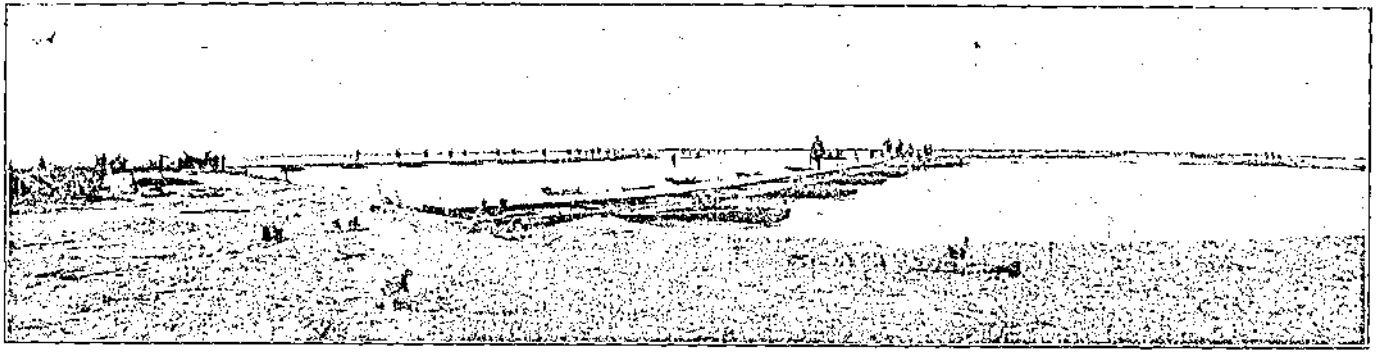
No. 3.—The Pontoon Bridge on October 27th.

On the right is the hut whose shadow appears on the water at "A" in the aeroplane photographs. Four Italian steel pontoons are followed by 3 British Welldon trestles. The first of the latter, which failed later, is already leaning. Empty pontoon waggons can be seen on the shoals, and the rest of the bridge is end on on the left of the men on the shoal. Pickets mark the original ford. Compare this photograph with Sketch No. 4, and photo No. 5.

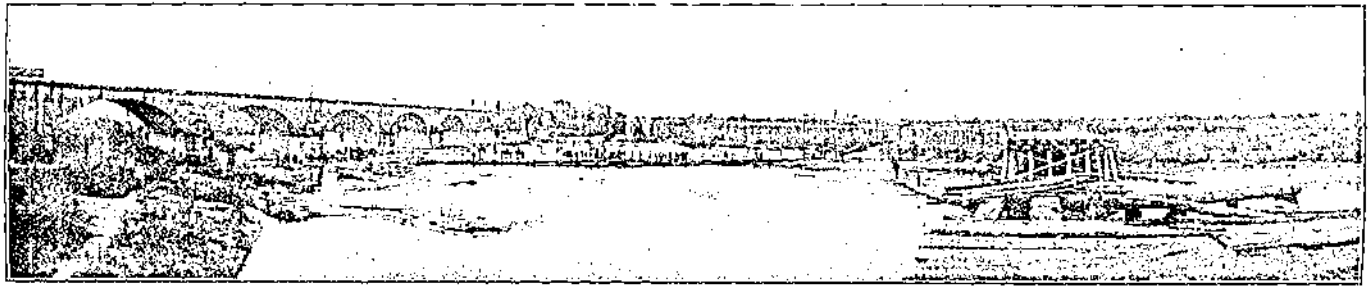




No. 5.—Austrian Prisoners—October 27-30, 1918—coming in over the Piave at Grave di Papadopoli.



No. 6.—Foot Bridges to Lido, Grave di Papadopoli. October 27th, 1918.



No. 7.—Wagon Bridge over Meduna, East of Pordenone. November 4th, 1918.

A WINTER IN WAZIRISTAN.

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

I.

SINCE the close of the Great War some space in the Press has been devoted at intervals to the long drawn-out operations on the North West Frontier of India, undertaken to bring about the subjugation of the Mahsuds, a tribe who have for many years been a thorn in the flesh of the Indian Government. These hardy, truculent mountaineers inhabit the heart of Waziristan; and for centuries it has been their boast that, while kingdoms and dynasties had passed away, they alone of all the Afghan clans remained free; that the armies of kings had never penetrated their strongholds; and that they recognised no other law or will but their own. Indeed, they regarded the Indus plains, impinging on their territory, as their own particular happy hunting grounds, whereon they could descend at pleasure from their mountain fastnesses to loot their less warlike neighbours, and enrich themselves at their expense. Thus, from the earliest days of our rule in the Punjab, formidable has been the number of raids these inveterate border marauders have made into British territory. Much enmity also exists between the Mahsuds and other Waziri clans, who encircle their haunts and have suffered greatly from their forays in the past.

Waziristan is situated along the western frontier of the Indian Empire, and has an average length of 110 miles from north to south, with a breadth of 60 miles. The country is extremely mountainous in character, being intersected in all directions by rugged ridges and ravines, radiating from lofty ranges and peaks that attain an altitude of 11,000 feet above sea level. The Mahsud area is a very barren one and practically unproductive, save for small patches of cultivation on *kaches*, or flat terraced plots of alluvial soil, generally at the base of the mountains and near the mouths of the principal defiles. Consequently, the struggle for existence by its inhabitants is severe; and to their lack of natural resources may probably be attributed the Ishmaelite outlook of the tribe, of whom it may be truly said that their hand is against every man. Their notorious plundering proclivities have, nevertheless, served to rear a race of men of fine physique and independent

bearing; whilst their women and children, too, possess the power to endure fatigue and hardships, under adverse climatic conditions, to a very remarkable degree.

Until the systematic construction of strategic roads during the past few years of occupation by our troops in India, the numerous water-courses and stony river-beds were the normal means of communication within this difficult region. Invading forces were necessarily restricted, therefore, in their advance on Mahsud strongholds to these primitive paths, crossing and re-crossing at frequent intervals the usually shallow streams that carve their tortuous way through impressive defiles, 'mid a chaos of hills, before uniting to form two or three rivers of some volume which finally emerge on the plains of India.

Along the beds of such mountain torrents, so vulnerable to attack by a brave and warlike foe holding the steep and often precipitous heights on either side, columns of all arms have to march on a narrow front, with their long line of transport animals stretching far behind. Always imperative is it, therefore, to clear these heights as the columns advance, and to crown them with picquets, which are required to maintain their position against any possible assault until the last of the baggage passes beyond each successive danger point throughout the seemingly interminable defiles of this forbidding country. The mobile, hawk-eyed enemy, tied to no line of communication and intimately acquainted with the topography of his homeland, is thus free to assemble at some rocky gateway of great natural strength to bar the progress of the invader. It is usually easy for him to melt away thence into the adjacent ravines and broken ground, when his powers of resistance are overcome or his line of retreat threatened.

Hence, it will readily be understood how difficult, if not impossible, it is to inflict a crushing blow in actual fight on so agile and elusive a foe as the Mahsud. Yet, seldom have they shown themselves capable of withstanding the steady converging advance of well-trained troops towards the heart of their country. After suffering comparatively few casualties in *personnel* whilst attempting to oppose such advances, they generally submit, for a time, when they see their villages destroyed, their tall defensive towers blown up, and their scanty crops utilised for feeding the animals of British columns. War being war, their women and children, and flocks and herds, would be forced to flee to remote asylums in the loftier ranges—fastnesses where great hardships must be endured, owing to their snow-bound character during the rigours of winter.

The purpose of this narrative is an attempt to convey impressions of one such winter spent in Waziristan thirty years ago, during the operations of an expedition in the heart of Mahsud territory. The Field Force in question was despatched to punish the Mahsuds for

an unwarranted attack on a Delimitation Escort camped at Wana on the western confines of their country, in the small hours of November 3rd, 1894. This escort, numbering some 3,000 combatants of all arms, was sent as a covering force to the Mission detailed to demarcate the new boundary between India and Afghanistan, which had lately been settled with the Amir at Kabul. The Mahsuds had been informed by the Government of India of its intentions. They were assured that their internal affairs would in no way be interfered with during the work of the Boundary Commission, and their friendly co-operation in the task was sought.

A fanatical priest, Mullah Powindah by name, persuaded the Mahsuds, however, that their ancient independence was menaced by the assembly of this force on the outskirts of their territory. He collected together a *lashkar* of 3,000 fighting men, who, under the cover of darkness, crept along various deep nullahs by which the camp in the open plain was surrounded, and thence launched a surprise attack at 5.30 a.m. So sudden was it that outlying picquets were overwhelmed, and many Mahsud swordsmen succeeded in penetrating to the interior of the camp. They were with much difficulty expelled at the point of the bayonet; but not before they had killed and wounded 120 officers and men, besides destroying more than 100 transport animals. They managed to get away also with a large number of rifles, some horses, and 3,000 rupees in cash, though it is estimated they themselves lost 350 killed during the assault and subsequent pursuit by cavalry at daylight.

For this unprovoked attack the Mahsuds were called upon to surrender nineteen of their leaders as hostages, to drive Mullah Powindah out of the country until the demarcation of the boundary was completed, and to restore all the stolen property. Failing compliance with these terms, punitive action would be taken to compel the submission of the tribe. During the negotiations which followed, it soon became apparent that the Mahsuds had no serious intention of carrying out the demands made; so, early in December, the Waziristan Field Force was organised under the command of Lieut.-General Sir William Lockhart, K.C.B. It consisted of three mixed brigades of all arms, directed to assemble at Wana, Dera Ismail Khan, and Bannu respectively, in order to invade Mahsud territory simultaneously from three widely separated quarters.

At that time the strength of the Mahsuds was estimated at from 10,000 to 12,000 fighting men. Of breech-loading rifles they probably did not possess more than two or three hundred, chiefly stolen from British territory by expert rifle thieves. The bulk of their firearms consisted of the *jezail*, a flint-lock muzzle-loader, and flint-lock pistols. The old *jezail* was a fearful and wonderful weapon, provided with prongs near the end of its barrel to steady the musket

when resting it on the ground or a rock, in order to fire from a prone or crouching position. The range of this medieval fire-arm did not exceed a few hundred yards; and the sword was then regarded as the chief weapon of the Mahsud. Brave and dashing, they courted hand-to-hand fighting with sword and dagger, in the use of which they were highly skilled; and on several occasions in the past they had unhesitatingly charged down, tulwar in hand, on disciplined troops armed with breech-loading rifles and bayonets, as at Wana. During the last three decades, however, the Mahsuds have acquired many breech-loading magazine rifles of precision by raids, thefts, and purchase from the Persian Gulf; so the sword no longer plays the important part in their tactics that it formerly did.

It was my good fortune to be attached to the 5th Company, Bengal Sappers and Miners, which formed one of the units of the 2nd, or Jandola, Brigade, commanded by Brig.-Genl. Penn Symons, afterwards killed at Talana in the South African War. The brigade assembled at Dera Ismail Khan, and then marched some sixty miles in a north-westerly direction *via* Tank to Jandola Post, situated on the right bank of the Takki Zam, there a broad stony stream, amid the foot-hills of South-East Waziristan. The force was here joined by Sir William Lockhart and his staff on December 12th; and a few days later our Chief received a letter from Mullah Powindah asking to be given one day's notice of the intended move towards Makin, and promising to put up a good fight for him somewhere *en route* by day! This sounded accommodating; but in spite of the fiery priest's sporting offer it was unlikely that precautions by night would be neglected by so experienced a frontier soldier as our distinguished Chief.

A cavalry reconnaissance made up the Takki Zam for a distance of seven or eight miles, on December 17th, was fired on; so when the brigade commenced its advance next morning, carrying fifteen days' supplies on a long train of 1,500 camels, it was anticipated that the mullah might prove as good as his word. Nevertheless the Mahsuds gave the column a wide berth, and in no way interfered with the picqueting of the heights on either side of the narrowing valley as the force marched to Murghaband, the point reached by the reconnaissance the previous day. Whilst a defensible camp was being pitched on a plot of rough ground a little above the bed of the stream, the sappers sallied forth on their first mission of destruction —the demolition of a tower perched on the heights overlooking the valley, and about a mile beyond the camp.

The tower was 16 or 17 feet square at the base, and solidly constructed with stone, timber and earth for about ten feet above ground level. From this foundation two stories rose aloft, built of sun-dried bricks, beams and mud, and furnished with loopholes all round. The height of the structure from ground to roof was

perhaps 40 feet; but far more imposing towers were met with later, particularly in the vicinity of Makin, where they frequently exceeded 50 feet in height, and were not less than 20 feet square at the base.

Still, this served very well as a beginning, and we were accompanied by a signaller, for the two generals in camp wished to witness the first act of punishment inflicted on the Mahsuds. Burrowing six feet into one side of the solid base with picks and crowbars, sixty lbs. of gunpowder were stowed snugly away at the end of the cavity, fuses fixed, and the bags of explosives well tamped. The mine laid, the generals were informed by signal, and the answer, "Go ahead" received. The fuses were lit, and we retired to a respectful distance. Presently a loud boom resounded far and wide, and the whole edifice appeared to be lifted bodily. It remained poised in the air, and seemingly intact, for one thrilling instant, and then gracefully collapsed with a thunderous crash into a shapeless mass on its original site. When the dense cloud of dust subsided much timber was extracted from the debris. This was quickly loaded on to mules and conveyed to camp, where it made a welcome addition to the fuel supply of the force.

The Mahsuds were evidently not best pleased at this desecration of one of their defences; and during the hours of darkness vented their spleen by firing into camp from vantage points to which our picquets were not entirely able to deny them access. The advance next day, however, was unmolested, though two miles short of our new camping-ground at Surimanja Kach the hillsides closed in to form the Ahnai Tangi, a narrow defile barely thirty yards wide, and hemmed in by nearly vertical cliffs. The river bed had necessarily to be followed throughout the march of eight miles, and we thus had an opportunity of appreciating the labour expended by the Mahsuds on irrigating small plots of artificially levelled ground, their *kaches*. In order to derive crops from these alluvial patches, the river water was caught some distance up-stream and gradually conducted to them by means of channels built up against the side of the cliffs. In places these channels were driven through spurs of shale and rock, the tunnels being occasionally 30 to 40 feet long. Commodious caves, too, hewn into the face of the cliffs, were passed at intervals, usually near cultivated ground, where additional shelter was apparently sought by the inhabitants when guarding ripening crops from birds and other animals.

Sniped as usual during the night, two miles next morning brought us face to face with the famous Barari Tangi. This prodigious portal to the heart of Mahsud territory had been the scene of a stiff engagement when General Chamberlain invaded the country in 1860; and on leaving Jandola it was thought that Mullah Powindah would be most likely here to offer the stubborn resistance he had

promised General Lockhart. But as we drew near, the commanding heights were found, to our surprise, to be completely deserted. The position was one of great natural strength, and admirably adapted to enable a weak force to bar the progress of a largely superior one; for the Takki Zam pierced its way by a narrow cleft through a chain of rugged mountains which crossed its course roughly at right angles. Yet Mullah Powindah and his vaunted hosts had made no attempt to barricade the entrance to this dangerous defile with rocks and trees, close at hand, Nor had stout breastworks of stone, *sangars*, been constructed on the upper slopes dominating the approach to this gloomy rift in the mountains.

The rear-guard, it is true, had been followed up and fired into, on leaving camp that morning; and during a later stage of the march a few Mahsuds rushed in among the camels from out of a branch ravine, and slashed several of those disdainful creatures with their tulwars before bolting for cover again. But these were minor annoyances compared to what they might have done had they decided to give battle at the Barari. Thus, we passed safely through this gateway, and camped without further molestation some seven miles beyond at Janjal, after blowing up two or three towers *en route*.

We were only eight or nine miles now from the populous centre of Makin, our immediate objective. Ten miles to the south of it lay Kaniguram, on which other important stronghold the Wana brigade was simultaneously advancing from the west; whilst from the east the Bannu brigade was steadily progressing through the hills to join hands with our brigade at Makin. The Mahsuds were thus threatened from three sides at the same time; and one can very well imagine that divided counsels were largely responsible for the lack of enterprise displayed at this juncture by our fanatical foe. Be that as it may, the opposition offered to the invading columns was almost negligible, and our north-westerly advance continued on Makin next day.

Some three or four miles above Janjal the Takki Zam was joined, at Do Toi, by the stream which led up to Kaniguram in a south-westerly direction. About a mile-and-a-half farther on we came upon Mullah Powindah's home, the village of Marobi, perched on a small plateau up the hillsides overlooking the vale of the Takki Zam. Makin was but five miles distant; so while the main body of the force advanced on that place the sappers were ordered to level Marobi to the ground. This work it was supposed would be completed before the rear-guard, at the tail of the transport, reached the spot. The huts proved of such a substantial character, however, that the task occupied us several hours. The rear-guard, engaged in a running fight with the Mahsuds, who were following it up and firing into it from the opposite slopes, had not apparently been

informed of our presence above at Marobi. It thus unwittingly passed along in the gorge below, leaving us and the small infantry escort attached to us in the air.

The Mahsuds were not slow to take advantage of our isolation; and as they reached the heights opposite they turned their attention from the rear-guard to the demolition party, on whom their fire was now directed. Soon the bullets began to fall around us whilst still busy at our work of destruction on the exposed plateau. Our assailants, on the other hand, were screened from view by the dwarf-oak and undergrowth with which the slopes on their side were clad. We were fortunate, therefore, to get off with the loss of one man, who was shot dead just after we had blown down the village tower as a grand finale. The poor fellow was speedily hoisted into a stretcher, the mules loaded up with the tools and explosives, and, seeking such cover as the open hill-side afforded, we marched off to overtake the rear-guard in the valley beneath. Though pursued by the fire of the Mahsuds for some distance, no further casualties resulted; and when the rear-guard was reached the withdrawal to the new camp at Makin was continued under its fostering care. The force was subjected to desultory sniping throughout the night, but little harm was done thereby.

After being confined to the narrow valley of the Takki Zam, it was a pleasure to find oneself on the comparatively open rolling uplands of Makin. Here we were over 6,000 feet above sea level, having steadily risen from little more than 600 feet about Dera Ismail Khan. Hence the cold at our present bleak altitude was severe, for it was the depth of winter, and sharp frosts were continuous. As all officers were restricted to the 80-lb. Field Service scale, including tentage, it was no easy matter to obtain a good night's rest, despite the fact that we slept in our clothes, supplemented by a 'sweater,' and a Balaclava cap drawn well over head and ears. Even then one shivered whilst lying on the ground under four blankets, notwithstanding a 'coat, warm, British,' and waterproof cloak being piled on the top of them. Since we experienced such discomfort, it is not difficult to picture the dire straits which the Mahsuds, men, women and children, were put when denied access to their villages and hamlets within striking distance of the advancing columns, and forced to seek cheerless comfort in the lofty ranges confronting us.

The main village of Makin was situated on the lower spurs of Pir Ghal, whose snow-covered summit looked down from a height of over 11,000 feet above sea level on the relatively fertile fields far below. The huts and habitations, 200 to 300 in number, were distant about one-and-a-half miles to the west of our camp; and several conspicuous towers stood out in an alluring manner from their midst. Elsewhere, other small villages and hamlets, each with

its own tower, were dotted about the plateaux and hill slopes of the valley; and as the area covered was considerable, stately towers were visible on all sides. A comparatively large tract of country in the vicinity had been brought under cultivation, the ground being skilfully arranged in a succession of narrow terraces by means of rough stone walls, to the tops of which the earth in rear had been laboriously levelled. Though fuel and water proved plentiful, the villages were found to contain little in the shape of supplies; for the grain had either been carried away, or so cunningly buried that its hiding-places defied detection, and the livestock driven before the fugitives. Consequently, the country provided virtually nothing for the maintenance of the invading forces.

Thus, a convoy of 1,500 empty camels, escorted by an Indian battalion, was ordered back to Jandola next morning to bring up more supplies; and I was detailed to accompany it with a section of sappers to demolish certain towers that had been provisionally spared during the advance on Makin. It was hoped to push through to Janjal the first march; but the convoy commander had been directed to await the arrival of a similar empty convoy from Kaniguram at Do Toi, the junction of the two streams previously referred to. Although we were fired on almost continuously as far as Do Toi, Mahsud markmanship was indifferent to-day, *jezails* apparently being the weapons chiefly employed against us; and their spherical bullets made more noise than accurate shooting.

The intended meeting-place was early reached, but not until 5.30 p.m. did the Kaniguram convoy come in sight, as it had been greatly delayed *en route* clearing the heights of snipers, and assisting the camels through some bad *tangis* and over steep passes. During our long wait at Do Toi we blew up a tower at leisure near by; and so late was it by the time the last of the Kaniguram camels arrived that it was decided all must camp for the night on the restricted spot we occupied. It worked out an unpleasantly tight fit for two battalions and 3,000 camels, as our indispensable grumbling beasts of burden were not exactly sweet-scented companions under such contiguous conditions.

The fine weather hitherto enjoyed now broke, and we were daily subjected to heavy falls of snow and sleet, which changed to rain as we descended into lower altitudes. All felt the cold intensely, in spite of the exercise of marching; for we became drenched by the elements above, and the constant wading backwards and forwards across the icy stream under foot. It turned bright and sunny again, however, the day we reached Jandola, and here Christmas Day was spent; but it proved a very busy one. Thousands of sacks of flour and grain, and other supplies had to be unstacked, and made up into camel loads; whilst the sappers were hard at work constructing roadways down from the elevated plateau on which the post stood

to the river bed below, in order to facilitate the descent of the 3,000 heavily-laden camels when the return to Makin began.

At this juncture trouble arose with the hired Powindah camel men, the majority of whom openly stated that they had had enough of it, and refused to accompany their camels back to Makin. This was rather serious, but fortunately there was a sprinkling of very good fellows among them, men who had spent some time in Australia with their camels, and during their sojourn in that land had picked up a smattering of English. As all the hired camel-men wore the usual Afghan garments, it was difficult to know which had travelled across the seas, and which had passed their lives bearing merchandise between Central Asia, Afghanistan and India. It was somewhat disconcerting, therefore, on addressing a brawny Ghilzai in one's most fluent Pushtu, to be answered by a cheery, "All right, boss!" in a strong colonial accent. Still, it was chiefly due to the influence of these Commonwealth wanderers that all objections were ultimately adjusted, and we were able to start off on our return trip to Makin on December 27th. I will revert later to the Powindahs, who are normally warrior traders who travel ceaselessly between Central Asia and India.

The Mahsuds in this area now displayed a disposition to be friendly. They even went so far as to picquet the heights for us, on their own initiative, and to wave large pieces of cloth in their hands to indicate that all was correct—presumably in the hope that their remaining villages and towers might be spared. As we approached the Barari Tangi, one sportsman was seen in a prominent position on the ruins of a tower destroyed by General Chamberlain in 1860; and from this conspicuous spot he continued to signal us along until the entire convoy was safely through the dangerous defile. The lesson was evidently being taken to heart by the inhabitants athwart our line of communications.

On our arrival at Makin we found both the Jandola and Bannu brigades camped on the plateau. During the past week several flying columns had scoured the country round, and many villages and towers had been demolished by the sappers accompanying them. On one occasion 1,200 head of cattle and sheep had been captured, and formed a useful addition to the meat supply of the force. Little opposition had been met with on these *daurs*; but most of the Makin towers and defences still remained to be destroyed.

A day or two later, the Bannu brigade set forth for Jandola by a wide detour to ferret out haunts not yet visited by the Field Force. Shortly after their departure the Jandola brigade despatched a flying column of all arms from Makin, in the hope of surprising a group of villages in the Shuran Valley, to the north-west, which were reported to be occupied and to contain much cattle, grain and fodder. The Shuran enters the Takki Zam about three miles beyond

Makin, and for the first mile or so above its junction the stony bed was dry. As we ascended, however, a tiny trickle appeared which gradually acquired the dignity of a stream. The valley narrowed rapidly, and soon became confined between high rocky crags. Snow was lying in many places, and three miles farther up the hill-sides were entirely covered; so when the village of Spin Kamar was reached at an altitude of 7,600 feet, it was selected for the night's bivouac.

Notwithstanding previous reports, the entire valley was deserted, and the villages cleared of everything save grass and large quantities of pine logs. One could not help suspecting, therefore, that the so-called 'Friendlies,' who clustered round the Political Officers in camp, were not above giving timely warning of intended raids to their fellow-tribesmen dwelling in the remoter regions of the mountains. These 'Friendlies" usually acted as guides to these secluded spots, so it requires no great stretch of imagination to suppose that, did they fail to send due notice to their brethren, their lives would not be worth a moment's purchase once the Field Force left the country. It would seem, then, that the system obtaining at that time was far from a sound one; and a distinct bar, in the opinion of many, to the secret rapid movement of punitive columns.

The Mahsuds were at least unable to remove their villages and defences; so orders were issued to blow up four prominent towers in the vicinity of Spin Kamar. Whilst these were being prepared for demolition, I was directed to take a section of sappers and destroy another large tower seen looming through the falling snow on a lofty ridge beyond. Before we gained it, a bend in the stream disclosed a second hamlet and tower. Leaving a few men to get this ready for mines, also, I pushed on with the remainder and a small infantry escort to my original goal. A piercing wind blew and the cold was bitter; so, in spite of our exertions, we were chilled to the bone while climbing the several hundred feet further which landed us alongside the tower.

For some time past the use of gunpowder had been abandoned by us, owing to its bulk, and we now only employed gun-cotton or dynamite for demolition purposes; but so damp had some of our gun-cotton primers become that we experienced great difficulty in detonating the charges inserted in the base of this wind-swept tower. No less than three miss-fires occurred; and it is always a ticklish task in such circumstances to approach a tower in order to readjust matters. Sometimes action has been unaccountably delayed, and the mine may suddenly explode when least expected, with fatal results. The tower finally down, we were glad to descend from our exposed position, for the cutting wind, added to the densely swirling snowflakes, had benumbed us as we toiled. Fortunately, the lower one was quite ready for demolition by the

time we reached it, and went up gloriously first shot. With pleasing visions of bright pine-log bonfires before us, we hurried on to the friendly shelter of the bivouac for the night. When safely ensconced there, though, the returning circulation of blood to feet and fingers caused excruciating pain.

Snow continued to fall steadily throughout the night; but the entire flying column contrived, in some marvellous manner, to tuck itself away into huts and sheds. Even the chargers and mules obtained shelter of a sort; and very welcome it must have been to these poor beasts, accustomed to the burning plains of India, for six or seven inches of snow were lying on the ground by morning, and the sides of the stream frozen. Thus, the labour of reaching, and demolishing, several other towers in the neighbourhood was much increased. The higher slopes of the hills encompassing this vale were clothed in extensive forests of pine, while mistletoe and holly in profusion imparted a truly Christmas atmosphere to the scene. Nevertheless, there were few regrets when we commenced the return march to the more salubrious clime of Makin, where we arrived shortly before dusk. Our total 'bag' of towers in the brigade now amounted to fifty; and there yet remained those in the immediate vicinity of Makin, which were dealt with during the next two days.

It is worthy of comment that before the brigade marched from Makin towards Jandola on January 5th, large numbers of Waziris began to assemble from all sides. They had doubtless been informed by the 'Friendlies' that the force was departing that morning, for several hundred of them congregated early, beyond the precincts of the camp. And there they squatted in scattered groups of five or six, like so many vultures, occupying commanding points on the far bank of the stream which flowed through the open valley to join the Takki Zam. Two towers just outside General Lockhart's camp had yet to be blown up, and barely had we left their shapeless remains, to overtake the rear-guard near by, when the Mahsuds surged forward to gather in old tins, and other such loot as had been cast away by the force during its fortnight's residence on this plateau.

Shots had been fired into camp the last two nights of our sojourn at Makin; and the usual sniping of the rear-guard took place during the day's march to Janjal. But the Mahsuds on this occasion came off second best, for eight of their number were killed and wounded by Gurkha scouts, stalking them from behind the heights that overlooked the line of march.

Whilst camp was being pitched at Janjal, a most deplorable accident occurred, resulting in the death of young Lockhart, nephew and A.D.C. of the general. Hearing a report from the direction of

Sir William's camp within the perimeter, several of us hurried thither to inquire into the cause of the explosion. To our dismay we found Lockhart lying on the ground, supported by two of the general's staff, and bleeding profusely from a bullet wound which had penetrated heart and lungs. The case was a hopeless one, and the poor young fellow only lived a few moments. It was at first thought that some disgruntled trans-frontier sepoy in the camp had wilfully fired at Sir William, who was talking at the time to his nephew and his other A.D.C., the only son of Lord Roberts.

All the troops in camp were immediately fallen in, and their rifles examined, while the general, placing his revolver under his arm, continued to pace up and down outside his tent pending the result of the inspection. This revealed nothing, and it was only when the bullet had been extracted from Lockhart's lifeless form that it was found to be a revolver one. Subsequently it was proved that the Indian servant of one of the general's staff officers, while lifting the revolver off his master's table, had inadvertently pressed the trigger. The bullet passed through the side of the tent and found a fatal billet in Lockhart, who was standing just outside with his uncle and young Roberts.

Only a few hours before the two A.D.C.'s had remained behind with the sappers at Makin to watch the two last towers being blown up, and then hurried on to rejoin the Chief. This untimely death of young Lockhart cast a gloom over the camp, for he was a very popular member of Sir William's staff. Preparations were at once made to have the body conveyed by forced marches to Dera Ismail Khan for burial in the cemetery there.

Owing to a recrudescence of Mahsud activity, the force halted for two days at Janjal in order to administer further punishment on this recalcitrant tribe. Neighbouring valleys were thoroughly scoured by flying columns, and additional towers and villages destroyed. The country traversed in these *daurs* was extraordinarily difficult, veritable canons being entered through which mountain streams flowed between lofty rocky walls, sometimes six to eight feet only apart. Often, too, sudden drops in the beds of the torrents occurred, creating obstacles which even the nimble-footed mules were unable to negotiate until smoothed away by the sapper. The columns were at the same time handicapped by snow and sleet, and rarely returned to the camp at Janjal before dark. Still, no concerted opposition was offered, the Mahsuds contenting themselves with taking occasional 'pot-shots' at officers, several of whom had narrow shaves.

Thereafter, the brigade was left severely alone, and reached Jandola without incident on January 9th. Here the whole Waziristan Field Force was concentrated for the first time, the Wana

and Bannu brigades having arrived some days before by routes to the east and west of ours. A large area of the Mahsud country had, therefore, been thoroughly explored ; and an additional haul of 3,000 head of cattle made by the Bannu brigade some twelve miles to the north of Jandola. The Mahsuds had certainly been harassed, and close on 90 of their defensible towers, and various villages, had been destroyed by the two Companies of Sappers ; but they were not yet brought to their knees.

Mullah Powindah, well out of harm's way in Khost, had lately addressed a fiery proclamation to his followers, reviling them as 'dogs' for permitting us *kafirs* (Unbelievers in the Prophet) to enter their country ! He now summoned all Waziris to join in a Holy War to drive the Infidels out again ; and spoke bombastically of fighting three pitched battles against us. Further, he called on all trans-frontier Pathan sepoys in the ranks of the invaders to desert from the British.

Such being his attitude, and the demands of the Indian Government yet remaining to be complied with, arrangements were made at Jandola to penetrate still other portions of Mahsud territory. But our experiences during that stage of the operations must be reserved for another chapter.

THE HUMAN ELEMENT IN WAR.

By MAJ.-GEN. C. P. SUMMERALL, Chief of Staff of the Army, U.S.A.

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WHILE the consideration of the human element is predominant in war, there is great necessity of comprehending it as an essential in the management of men in peace. Indeed, if one does not understand and practice the art of controlling the human element in peace, he cannot do so in the test of war. It is trite to say that the human element remains, as it has ever been, the determining factor in battle. Machines and arms may be multiplied and changed, but the man who uses them will determine the final issues of victory or defeat. The psychology of men is a definite quality. It cannot be changed. To be used it must be understood and taken as it is fixed by nature. It can be used to bring about results just as successfully in garrison as in campaign. Indeed, the qualities of discipline, morale, efficiency, loyalty, etc., are only evidences of the degree to which some leader has directed the psychology of his men. For example, to-day we are concerned by a high rate of desertions. Yet we find organizations where the same evil exists only slightly, if at all. Some posts have large numbers of men absent without leave, while others are proud of their good record. Most evidences of indiscipline are capable of being corrected or removed by methods that take advantage of the human element, for any given number of men are essentially the same in the human characteristics as any other like number of men. It is not so much the fault of those responsible as it is their lack of understanding and, in some cases, the aptitude to apply a few psychological principles. All of our schools should teach the theory and practice of dealing with men according to methods that are readily understood. While everyone would not be equally successful there would be marked improvement in all standards, and the officer who lacked sufficient aptitude would subject himself to elimination.

While much has been written on psychology, the principles needed by the military leader are few; but they must be so thoroughly assimilated that they become a part of his life and personality. The following truths are stated as some of the more essential guides in directing the human element both in peace and in war.

MEN THINK AS THEIR LEADERS THINK.

This is absolutely true in every echelon of military command. Thoughts are things, in that a man cannot act or talk other than as he thinks. If an officer wishes to influence his men he must actually be what he desires them to become. A single disloyal remark or act

will spread through the minds of his men. He not only will be unable to lead, but he will deprive them of the will or the power to follow. On the other hand, a resolute, loyal, unquestioning leader of any grade will inspire his men with his own indomitable spirit. Thus they will react upon each other, and perfect confidence will make an invincible unit within its power, be it a squad or the largest command that one personality can permeate. The power of example thus becomes the measure of leadership.

All Impulses Come from the Top.

From the very nature of command the minds of subordinates turn to the leader for direction. A military unit can be no stronger or more efficient than the leader. A subordinate may influence his echelon, but he will not affect other echelons or higher elements. Human nature is jealous and proud. A leader naturally resents the effort of a subordinate to instruct or guide him, and is thus not receptive of influence from below. From this it follows that if a command of any size is good or bad, one has only to fix the responsibility upon the leader.

The real leader will give his subordinates credit for all of their accomplishments, but he can no more escape a similar honour from them than he can escape blame for failure. The true leader not only initiates impulses for his subordinates, but he adds force to impulses from above. With a chain of such leaders an order gathers momentum, and on reaching the point of execution it strikes with an irresistible force.

Men Fight for their Leaders.

The average mind is such that it does not analyze abstract causes or even the great principles over which wars are fought. Men are elemental and practical and cling to real things. They want to have leaders. They want to admire them and they want to follow them. After the classic assaults at Plevna, General Skobeleff II divided men into three categories: A small per cent. have no sense of fear and are eager for combat. They will expose themselves recklessly and soon become casualties. Another very small per cent. have not been endowed with enough courage to sustain them in danger, and they will soon disappear. The great majority of men in face of danger gladly surrender their wills to their leaders, and are easily controlled and guided. These are the men who properly commanded will win the battle. Danger, hardship, and tragedy develop a peculiar bond between men of all ranks, for basically, human nature is the same. As one real leader has expressed it: "In the face of death all men are equal." Thus men come to have a perfect and almost childlike confidence in a successful leader. The man who in any unit shows sympathy, helpfulness, and comradeship for his men may be sure that they will fight for him. To secure this

response a leader must be known to his men, and must be seen by them at the point of danger as well as elsewhere. They must know not only his name and appearance, but his record, and they must have personal proof of his care.

MEN RESPOND TO APPROVAL RATHER THAN TO BLAME.

Men do not fight for fear or for material reward. Courage and fortitude are spiritual and are not influenced by material considerations. A man fights for pride in himself and in his command. Pride is a basic element of human nature. There is no human being wholly devoid of self-respect. The soldier is especially sensitive by reason of his subordination, and when once his pride is aroused he becomes intensely solicitous and jealous of preserving it. In the same way he becomes loyal to his command and his comrades, and he would forfeit his life rather than act unworthily of them or incur the censure of those whom he respects. His sense of justice requires that his good performance be recognized, and where such recognition is withheld he experiences discouragement and depression. His richest reward is recognition by his leaders. This may vary from a simple word of approval to the highest decoration or citation according to his merits. On the contrary, censure or blame rouses the equally elemental quality of self-preservation. The man who humiliates his subordinates or who abuses his authority will forfeit their respect and arouse their antagonism or their hatred. Men want and admire firmness and positiveness, but command must be exercised so as to leave no personal sting. True discipline comes from pride and not from fear. Arbitrary and harsh measures may be easier to adopt, but they will multiply troubles out of all proportion to the gain.

The ways by which a leader's hold may be obtained on men are few and simple. He must live and conduct himself so as to be worthy of their respect. They are unerring in their perceptions, and they not only quickly discover but they abhor shams of every kind.

Men demand a reasonable degree of justice. They expect a leader to be fair and understanding. A single act of glaring injustice will injure his prestige and influence. Men must trust their leader in order to follow him.

It goes without saying that men demand the same courage and fortitude in the leader that they are expected to possess. A single evidence of timidity will end his usefulness. It is, perhaps, for this reason that officers have at times unduly exposed themselves and suffered unnecessary casualties.

Men are easily discouraged in the face of hardship and unreasonable tasks. With the loss of physical strength and with the exhaustion that is inseparable in campaign, the mind becomes correspondingly weakened. The leader must know how to assign missions possible of accomplishment under the conditions and to organize his resources

so as to make success reasonably sure. Repeated failures can only result in a loss of confidence and in ultimate loss of morale.

Men are pleased by having their superiors know their names and something of their performances. While the limitations of higher commanders are soon reached, in the lower echelons a leader should make every effort to know his subordinates personally, and make them realize his individual interest in them.

Men read the expression in the face of their leaders and are unconsciously influenced by their appearance, manner, and tone of voice. Self-control becomes, therefore, a vital attribute of a leader. To be calm, self-possessed, and self-confident is indispensable. A leader must not only believe that he is right, but he must be so sure of it that he will convince everyone else, by everything he says and does, that his plans and purposes are right. Thus he will make men sure of success, even though the plans might not be the best that could be adopted.

Men are capable of understanding the tasks demanded of them and the purposes to be accomplished. They respond eagerly to the leader who will talk to them and explain their accomplishments, their situations, and the necessity for further effort. Thus they require a personal relationship toward the leader and a personal identification with his plans. Each man comes to feel an individual responsibility to perform his part, even to the extent of feeling that success depends upon his own efforts. In this way the leader accomplishes not what men think they can do, but what he knows they can do. He dispels imaginary evils and obstacles and creates a state of mind and a method of thinking that add immeasurably to the fighting power of his command. Indeed, many difficulties are wholly imaginary. Defeat comes not so much from physical effects as from a state of mind which makes men reduce or cease their efforts. When properly identified with his troops, the personality of the leader remains in their minds, and in the stress of battle his influence encourages them and strengthens their resolution.

Within the limits of personal contact, men should be encouraged to go to their superiors with their difficulties, and they should find help or be convinced of the reason why it can not be given. The strongest nature needs human sympathy at some time, and a single act of consideration and help may change the entire career of a man for good.

These precepts may be somewhat commonplace and unscientific, but they embrace the essentials of human nature. The greatest responsibility one can have is to be entrusted with the lives and the sacrifice of men, and even the fate of one's country in war. No labour is too exhaustive, no effort too great, and no detail too small for those who, as officers of the Army, have dedicated themselves to the motto "Duty, honour and country."

CROSS-COUNTRY VEHICLES.

By Major G. Le Q. Martel, D.S.O., M.C., R.E.

[*Note.*—The views expressed in this paper are the writer's own views and do not necessarily agree in every case with the official view.]

Experience from the Great War.

There were many lessons to be drawn from the experience of the Great War, but three considerations of great importance were directly connected with the provision of cross-country vehicles.

The first of these three was the necessity for an armoured cross-country vehicle—the tank—to enable the attacker to overcome the strength of a modern defensive position.

The second was the necessity for cross-country transport to supply an army with munitions and supplies during an advance. This was felt particularly on the Western front, where the troops were very concentrated and where an advance usually took place over an area in which roads and railways had ceased to exist, but extensive demolitions might easily be carried out in open warfare and the necessity for cross-country vehicles for supplies and ammunition would be just as great. Horse transport was used for this purpose during the Great War, but this form of transport could not compete with the demands owing to the small loads carried and comparatively low speed of the transport. In colonial warfare the inefficiency of horse, mule or camel transport is even more marked and the necessity for mechanical cross-country vehicles is very great.

The third consideration was that, apart from the question as to whether horse transport could compete with the requirements in the field, transportation and particularly oversea transport could not compete with the tonnage required in fodder without seriously handicapping the available tonnage in transport for munitions of every kind. If it had been possible to change over from horse transport to mechanical cross-country transport throughout the army, the saving in tonnage due to the change from fodder to petrol and oil would have been in the neighbourhood of 50,000 tons per month.

These considerations were fully realised before the end of the war, and very large orders were placed for tractors for transport work in the forward area, towards the end of 1918. Whether these tractors,

The track vehicles which we considered necessary just after the war for transport work in the forward areas shewed very high running costs, and were totally unsuitable for this work in the colonies. The first problem to be tackled was, therefore, the production of an efficient track vehicle which could be run economically for transport work. It was then hoped that this would produce a demand for these vehicles from the colonies and a production programme in the factories at home to meet this demand. There would then always be a large number of tractors awaiting export and the machinery would exist for the rapid manufacture of these vehicles. This would to some extent solve the difficulty of mobilising transport from civilian resources in the event of war, and although it was not a very satisfactory solution, yet it presented fair possibilities and no one could suggest anything better.

The research work to produce the efficient tractor, however, presented many difficulties. The main sources of inefficiency were undoubtedly the system of skid steering with the track, and the employment of unlubricated track pin joints which gave rise to rapid wear. Many experiments were carried out with tracks which had lateral flexibility and laid themselves in curves to negotiate bends, and much progress was made in this direction. Unfortunately, however, research work is always slow and this case was no exception. The work applied equally to all track vehicles and tank design was affected just as much as tractor design. At the end of two years there was nothing very practical to show for the expenditure of much money and time, and the provision of new fighting tanks was an urgent necessity. The Vickers tank was therefore constructed, and although it was in no way more efficient as a transport vehicle than any previous track vehicles, it was a great improvement on previous whole-track machines, and provided a useful fighting machine that was urgently required. At the same time the artillery dragon was constructed on practically identical lines with the Vickers tank. With artillery the saving is so great by changing over from horse transport to mechanical vehicles that it was possible to supply a full scale of transport in peace and still provide a small financial saving in maintenance. Hence the dragon—though it has the same disadvantages as any other track vehicle—has been adopted for certain natures of artillery work. The main problem, however, of providing a form of mechanical transport suitable to replace the horse transport of all units remained unsolved. The track of a vehicle such as the artillery dragon has a life of 1,000 to 1,500 miles only, and costs some 5 shillings a mile for track replacement alone, and in addition the petrol consumption is $1\frac{1}{2}$ miles per gallon. This represents a running cost about 8 times higher than a lorry on a road, and there was no chance at all of any commercial use for a vehicle with such very high running costs.

Later Progress.

From 1922 onwards a new line of development was started which gave great promise. By this time we had got rid of our ideas of shell-torn ground and battlefields intersected in every direction with trenches. We realised that although extensive demolitions might make it as important as ever to use cross-country transport, yet that transport would not have to negotiate shell holes, craters and trenches. This made it possible to visualise a form of transport which had much greater possibilities of being adopted commercially. Two types of cross-country vehicle were tried out to see if they would fill the requirements for general transport work in the forward areas; these were the lorry with large pneumatic tyres and multi-wheel drive and the half-track vehicles, i.e., lorries with wheels in front and short tracks in place of the rear wheels. Both these types will be described in some detail later. As regards tanks it was considered essential to use whole-track vehicles; tanks may have to cross wide ditches or force their way over steep banks and hedges which could not be negotiated by a wheeled vehicle. For first line transport it is usually possible to choose a course which avoids serious obstacles, or in any case ditches can be roughly filled in and hedges cut down in a very short time if necessary. If a commercial vehicle can be obtained for use as first line transport, the advantage is so great that it is worth while accepting a lower standard of obstacle-crossing capacity, and this point was fully realised at this stage. The transport of field artillery presented a problem somewhere between that of first line transport and fighting vehicles. The dragon served the purpose very well, but it was a very expensive article (nearly £4,000), and the running expenses were very high; half-track vehicles were, therefore, tried for artillery work as well as for transport work. The general idea, therefore, was to stimulate the trade to produce half-track vehicles or multi-wheel lorries, to fill a known demand from the colonies, and it was hoped that this might lead to a possibility of obtaining these vehicles at short notice from the trade for use in war.

The Present Position.

Half-Track Vehicles. The appendix gives details of most of the various half-track vehicles at present under test. They are divided into two types—those using steel tracks—and those using rubber tracks. The steel tracks are made by Roadless Traction, Ltd., and the track plates are joined by a lubricated ball joint giving lateral flexibility, so that the lorry steers very easily without any skidding of the track on the ground. This increases the life of the track and slightly increases the overall efficiency of the lorry, but the track itself is about twice as expensive as a cheap type with unlubricated joints. It is difficult to say whether at the present stage of develop-

ment, there is any material advantage in the more expensive type of track over the cheaper one. It is probable that the increased life of the track with the lubricated joint rather more than compensates for the increase in expense, but against that is the labour of lubricating all the joints, which takes about one hour every few hundred miles. If it was possible to keep mud and grit out of the joint, the lubricated track would have a very great advantage over the cheaper unlubricated type, but, unfortunately, no system has yet been invented which is successful in achieving this result, and after about 1,000 miles the mud or sand begins to work its way into the joint and very rapid wear then ensues. The rubber tracks have a long life on sand or good roads, but get cut up very badly on rocky or stony ground. The tracks have no lateral flexibility and in consequence the steering is heavy on sharp corners, though this is not sufficiently bad to be a serious disadvantage. On greasy mud the rubber tracks slip more than the steel tracks, and slips sometimes occur between the driving wheel and the rubber track. The lorries with rubber tracks are, however, lighter and faster than those with steel tracks. Half-track vehicles are in use experimentally for field batteries and first line transport.

Multi-wheel Drive Lorries. The appendix also gives a list of the main varieties of lorries using four or six wheels and driving on four wheels. The first service model was the Hathi Tractor. This is a Thornycroft four-wheel tractor with the drive taken to all four wheels. This tractor can put up a very creditable cross-country performance, but fails rather badly on wet greasy clay banks. It is, however, fitted with a winding drum and, when used for towing guns it can surmount difficult obstacles and wind the gun up afterwards. The Hathi was, however, an expensive vehicle and made no progress commercially.

The next type to be developed was the six-wheel lorry. This is practically an ordinary commercial lorry with a second differential and back axle behind the usual one, and the drive taken straight through on to both axles. These six-wheel lorries are capable of a very remarkable cross-country performance. Some of them have twin wheels on each driving axle, so that the drive is taken through eight tyres, and a special type of non-skid chain can be fitted between these wheels and connecting the two driving axles. This practically has the effect of converting the lorry into a half-track vehicle and greatly increases its obstacle-crossing capacity. The chains are apt to damage the tyres if used continuously on good "going," on which their use is not called for. As very little time is required either to fit or remove them, and they are only needed for very bad conditions, the tyres are not damaged if the chains are used with discretion.

These six-wheel lorries represent the greatest advance that has been made since the war in the design of load carrying cross-country vehicles; a certain number are being made commercially for transport work both at home and abroad, and the prospects appear very promising in that direction. The designs were initiated by the R.A.S.C., and developed by civilians and officers who were qualified mechanical engineers. This provides an outstanding example of the advantage of employing qualified mechanical engineers in the development of new mechanical vehicles or munitions generally.

Tanks. An important development has been carried out recently in the introduction of wheel-cum-track transmission. This was first tried on a large motor car; the wheels are mounted beyond the tracks, in front and in rear; by mechanical power the tank can be raised on to the wheels or lowered on to the tracks and the transmission applied to either. This development brings great advantages; instead of wearing out the tracks on a long approach march, causing considerable financial expenditure and loss of efficiency, the road work is done on wheels shod with solid rubber tyres, and the tank changes on to tracks for cross-country work and fighting. The present system is, however, very cumbersome and expensive, and if we accept a method which takes a few more minutes to change from wheels to tracks or vice versa, a much simpler system could possibly be introduced.

Another recent development is the introduction of one and two-man tanks. The general idea in this case is to produce very cheap tanks so that large numbers can be produced and maintained for a given sum compared with Vickers tanks. The engine and transmission in these tanks are commercial components and the tanks could be produced rapidly and in large numbers in the event of war.

Conclusion.

Transport vehicles. For general transport work across country there is little doubt that the six-wheel lorry is a long way ahead of any other type of vehicle. It is comparatively cheap to buy and maintain, and as it is made almost entirely of commercial components it can be obtained rapidly and in large numbers from the trade. In addition, there is a fair chance that a number of these lorries will be used commercially in this country under a subsidy scheme, thereby providing some reserve for mobilisation in the event of war. The half-track vehicle will always possess certain advantages for special work; for instance, for gun haulage the half-track may have certain advantages. In this connection it is not impossible that the solution for field artillery may lie in six-wheelers which carry a field gun.

Arrangements could be made for the gun to be hauled up onto the lorry or lowered off very rapidly and the capabilities of a six-wheeler as a road vehicle would present a great advantage.

Track Vehicles. As regards tanks and whole-track vehicles used for heavy transport work across country, the most urgent necessity is some means of enabling these vehicles to move on wheels along roads so as to avoid the wear and tear of a long approach march before battle. It is the lack of these means that renders the Vickers tank so unsuitable for use in India and in Colonial wars, and during the general strike this necessity was much felt when it was desired to move tanks to the North of England. With the light tank weighing about 12 tons, it should be possible to design a float which would carry the tank and be propelled by the tank engine through a dog clutch from extensions through the sprocket wheels, and the same remarks apply to the Dragon also.

Swimming Tanks. There is no particular difficulty in constructing a swimming tank, but it is almost bound to be much less efficient as a fighting machine on land than a non-swimming tank, owing to the fact that the bulk has to be increased and armour and armament reduced to enable it to float. It would appear to be worth while to construct one or two such machines experimentally, so as to be ready to produce them if required for a special landing operation, or for forcing a passage across a river, but it would, of course, entail considerable expenditure. A cheaper solution is to attach floats to the side of a fighting tank for use in these special circumstances, and it is possible that this may be tried experimentally in the future.

Research Work. The research work into the use of lubricated track pins and lateral flexibility which was carried out for two years after the war, has been continued since, but lack of funds has rendered the work spasmodic. Whether the work will ever produce practical results for the smaller vehicles such as light tanks is doubtful, and it may be that the best solution will lie in the cheap type of expendable track, but for heavy tanks and any form of heavy track transport that may be needed, there would be very great advantages in the use of lubricated joints and lateral flexibility if the problems can be solved by applied research.

The various types of cross-country vehicles referred to in this article are tabulated on the following page:—

TABLE OF TYPES OF VEHICLES.

Group.	Vehicle.	Weight.	Engine.	Speed on the road m.p.h.	Speed cross country m.p.h.	Radius of action. miles.	Useful load tons.	Remarks.
Rubber half-tracks	Citroen Kegresse	tons cwt. 1 16	Citroen 11.4 h.p.	18	10	90	½	Used for reconnaissance. Will be replaced by the 15 cwt. Crossley Kegresse.
	Crossley Kegresse 30 cwt.	3 12	25 h.p.	20	10	74	1½	General purpose cross-country transport vehicle. Also used as tractor for field artillery.
	Burford Kegresse 30 cwt.	3 14	28 h.p.	20	10	90	1½	Ditto.
Steel half tracks.	Morris Roadless 1 ton.	3 0	16 h.p.	18	10	70	1	General purpose cross-country transport vehicle and special design is being tried as a Field Artillery tractor.
	Four Wheel Roadless.	5¼ 0	42 h.p.	13	5	120	3	General purpose cross-country transport vehicle and being tried as a tractor for medium artillery.
Four wheel drive.	Hathi (Thornycroft)	5 4	54 h.p.	20	10	100	—	Used as a tractor for general purposes. Can haul 10 tons by road and 5-7 tons cross-country. Has a winding gear with a drawbar pull of 7 tons.
Six-wheelers.	Morris light six-wheeler.	2 8	16 h.p.	30	10-15	100	30 cwt. by road 1 ton cross-country	Similar vehicles are being made by Crossley Motors, Vulcan and other firms.
	Thornycroft medium six-wheeler	3 15	22 h.p.	25	10	100	3 tons by road 2 tons cross-country	Similar vehicles are being made by Crossley Motors, Guy Motors, Karrier Motors, Leyland Motors, Vulcan Motors, Albion Motors and others.

YACHTING IN KASHMIR.

By Lieut. M. R. Jefferis, m.c., R.E.

Sailing in Northern India has been limited in the past to Naini Tal. This lake is about half a square mile in area, and is completely surrounded by mountains which come straight down to the water. On the precipitous slopes of these the wooden bungalows of the hill station are perched. At one end of the lake on the only bit of level ground in the place, a miniature polo ground has been cut out.

I believe there is a class of 9 or 10 yachts on the water, which during the season race every day.

The restriction of the airway causes a great divergence in the direction of the wind at various points on the lake at the same moment, and the casualties caused by strong gusts blowing down nullahs are innumerable. The club dispenses dutch courage on the water's edge on squally days, and after the race is the meeting place of the yachtsmen while performing the post-mortem on the morning's sport.

To those on the frontier, as many of us find ourselves, Naini has only two detractions. It is a long way to go, and the savings accumulated for the purpose of leave evaporate with startling rapidity.

The yachting on the Wular Lake in Kashmir is at present cast in a sterner mould. There are no clubs nearer than Srinagar, 30 miles away, and one has to live either in camp or on a houseboat. This is not such a difficult *bandobast* as it may seem. Any of the agencies in Srinagar, given two or three days' notice, will instal a camp or a houseboat complete with servants, provisions, and furniture, at any place and at any time one may appoint. In fact, one can arrange to go straight to the camp site or houseboat and find dinner on the table and the khitmatgar's finger print in lieu of a crest on the edge of the plate. Living under these conditions falls also under the unprecedented and phenomenal category of being within one's pay.

This last month, with a party of seven, including all expenditure on hire of tents, drinks, servants, etc., living worked out at Rs. 5/- per head per diem, so that the leave was not an expensive one.

The Wular Lake, situated in the north-west corner of the Srinagar plain, is fed by the Jhelum river, and is nearly fifty square miles in extent. Its altitude is 5,170 feet, which, in common with the whole

of the Srinagar plain, makes the months of July and August warmish. The Wular, however, is probably cooler than the rest of the plain, as the water is always much cooler than the shade temperature. The difference in the temperature of the Wular and the smaller and shallower Dal lakes is very marked. This is due to the storms stirring up the water and bringing the cooler lower strata to the surface. Bathing in the Dal lakes without this advantage becomes too hot to be refreshing.

The northern half of the Wular is surrounded by mountains which slope down gently to the water's edge, while the southern half is open to the Srinagar plain.

The sudden storms which blow across the lake, chiefly in June and July, are a source of great anxiety to the local inhabitants, whose ricketty fishing *shikaras* and heavily-laden *doongas* are soon swamped by any sea. In fact, no amount of extra payment will persuade these fellows to cross the lake after two o'clock in the afternoon. As soon as a blow starts every craft on the water scurries for the weeds. Here they are safe, as nothing except a slight swell penetrates more than twenty yards through the embrace of the sangara and the lotus tendrils.

The usual sequence of events on a stormy day is that first, early in the afternoon, a few fat white clouds show poking their heads above the mountains: then one valley will be seen to fill with mist. When this becomes dense, a long line of broken water starts away from the shore and in a few minutes a steady strong wind sets in.

This is now the time to look out for squalls.

If you are out in the middle of the lake, a bad squall will appear as a line of white mist about six feet high crossing the weeds. This is caused by the water being whipped up from between the weeds and carried along by the force of the wind. If you are close to the willows at Ningle, watch for intense agitation in the topmost branches. If you are under Baba Sheikbadin, the only mountain that comes straight down to the water, standby to let everything go at once, as the squalls that drop down from the top of this ill-omened hill fall almost vertically on the water and spread out in all directions at once.

As offsets to the gaieties of Naini Tal, one has first one of the grandest panoramas in the world as a background to one's holiday; from the buttressed peak of Haramak overshadowing the water from a distance of 20 miles, to the eternal snows lying softly on the peaks of the Pir Punjal to the south across the plain, with every detail, every stone, reflected faithfully in the water on a still day.

Then there is shikar of all sorts.

Small game, chiefly chikor, are plentiful in the foothills all round the lake in September and October. In the same months, to witness at dawn the flighting of the duck hurrying across the water to their

feeding grounds in thousands in the half light is an experience never forgotten. Mahseer can be caught in the Jhelum up to a weight of 50 lbs., so the story goes.

To those not content with sea sickness, mountain sickness can be obtained anywhere on the slopes of Haramuk above 14,000 feet. The local inhabitants believe this is caused by a wind blowing over a poisonous bush. On it being pointed out by a European that there were no bushes growing at this height, a villager answered: "Yes, the bush is invisible, and that is what makes it so very poisonous." This form of argument is much favoured in the East, and is incontrovertible.

And then, first or last, wherever you like to put it, comes the sailing.

For the yachts, let me first write down my thanks to Col. S. F. Biddulph, who fixed the design and built them all practically with his own hands.

The type of boat is what the Americans call a skipjack, which is a cross between a punt and a round bottomed boat; having vertical sides and a slightly rounded bottom. The chine, where they meet, just disappears at the stem.

The yachts are fitted with wooden centreboards and are partly decked in. The stern is cut square.

The dimensions are: length 19 feet, plus 3½ feet bowsprit, beam 7 feet, draft 9 inches, plus 3 feet centreboard.

The boat with live ballast aboard floats on a level keel with the chine just touching the water amidships, there being about twelve inches freeboard.

The yachts carry a mainsail and staysail made by Ratsey and Lapthorne, whose handiwork is everything that could be desired.

The factors affecting the design of the hull are:—

(1) That the Wular Lake is nearly completely surrounded by a belt of weeds through which a drop keel boat could not sail or a man swim. This latter factor makes it essential that the boat will float high when full of water.

(2) That under the influence of half-an-hour's steady blow down the eleven mile stretch of water from Bandipore to Ningle the lake presents a short, sharp choppy chequered effect with waves five feet high from trough to crest, surmounted by white and broken water embarrassing even to the dauntless mariner. This factor excludes any punt, skow, or dinghey design which would be compatible with the other factors.

(3) That the material available is only deodar, and that there are no carpenters with even the most rudimentary knowledge of the shipwright's trade, nor is there any facility for steaming either ribs or strakes. A round-bottomed carvel-built boat would, therefore, be beyond the scope of local endeavour.

(4) That any attempt to build a round-bottomed boat elsewhere, with better materials, would put the cost out of reach of most of us.

(5) And lastly, that four of the class have already been built, so that really the matter is settled, and there is no point in arguing about it at all.

In practice the hull has proved most satisfactory, being fast through the water and under full control of the tiller. The only disadvantage is a tendency to slap down on the waves and come up practically all standing when beating into a heavy sea. The absence of ballast except for the crew makes the boat exceptionally lively. The boat weighs approximately 700 lbs., and may carry a crew weighing nearly this weight, so that the trimming of the boat by the crew becomes a problem of primary importance. This factor, of course, is not so marked in a boat carrying dead ballast. The skipjack, therefore, provides when racing a still further complication to the already harassed yachtsman.

This last June we were exceptionally lucky in the matter of wind, and the following incident may be of interest, in that it gives some idea of the behaviour of the boats under exceptional circumstances.

One yacht left Ningle on a squally afternoon with three in the boat, under full canvas, and was flattened out on the water by a sudden squall from the west between buoys 1 and 3. Luckily we were out in our boat on a pleasure trip with eight on board, coming down from Zurimaur on a beam wind. With the mainsail reduced by two reefs, and with plenty of live ballast, our boat behaved admirably. We saw the other boat go over when we were a mile to a mile-and-a-half away. When we arrived on the scene of the accident, we found the boat lying on her side floating nearly half out of the water; with the three survivors sitting on her side and with the seas breaking over them continually. Then suddenly the peak of the sail which was to windward lifted out of the water on a sea and was seized on by the wind, and at once the whole boat came up on to a level keel, only to be flattened out again on the other side, with the boat's crew underneath. They, however, soon appeared on the surface again, and with considerable difficulty regained their perch via the centre board.

When we had transferred them to our boat we found that they were in a state of considerable exhaustion, although they cannot have been in the water more than a quarter-of-an-hour.

The moral of this is not to take risks of capsizing in stormy weather, unless there is someone at hand to pick you up.

A rough rule for reefing would be:—

With two or three in the boat, when you see white caps on the waves take one reef. When you see a squall coming take two reefs. With four or more in the boat one reef less is sufficient, but the strain on the rigging may be more than it can stand, and unless you

have every confidence in your wire rope splices, it is inadvisable. The bobstay, especially, should be watched, as its purchase is very poor, due to the shallowness of the boat, and probably takes between two and three times the pull of the forestay.

Our yacht was bought by a syndicate of five R.E. Officers, all serving on the frontier, who put up equal shares of Rs. 370 each. This included the cost of the motor *shikara*. Under the present average rate of leave, about seven people sharing one boat would not be overcrowding, so that there is plenty of room for more members. If we can get half-a-dozen more we would be able to run a second boat.

Our boat was finished at the end of May except for the running rigging which we were going to fix ourselves. The one-inch hemp which we had ordered from Ratseys had not arrived, so we used cotton rope purchased locally. This rope looked very well, and after a little stretching, ran evenly through the blocks. We found to our cost while racing, however, that there is too much stretch in cotton, and that a gaff well peaked up at the moorings was nowhere near it when the wind filled the sail. We have now replaced the more important tackles with hemp.

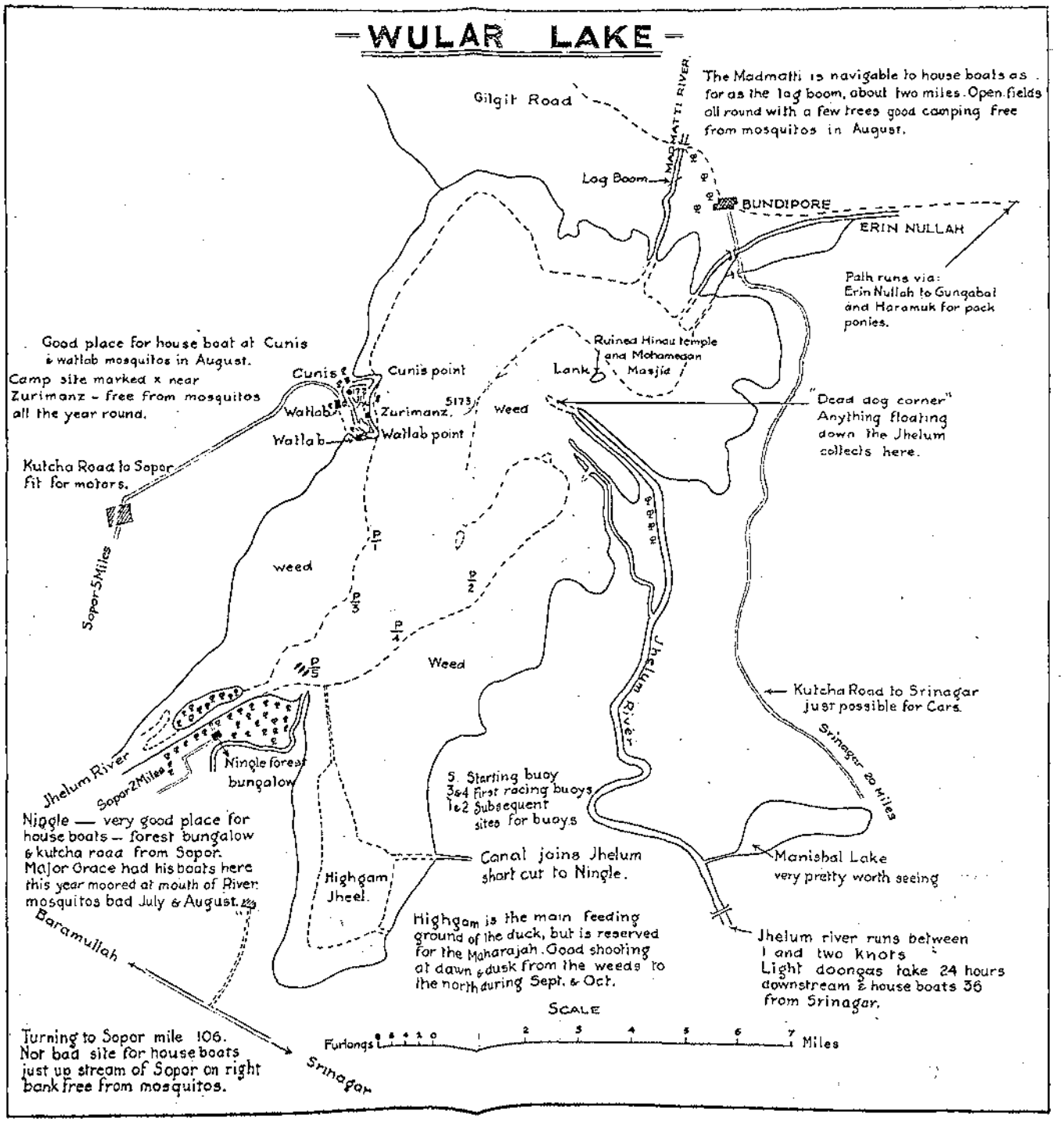
Before we left Srinagar we bought a *shikara*, which is the local form of small craft, and resembles a punt with attenuated ends carried to points. The sides and bottom are planks bent in and running from stem to stern, in one piece, there being no ribs. In this we cut a well and fixed an outboard engine over a false transom. This contrivance gets along at five or six knots, and tows the yacht as well at four or five knots.

The motor *shikara* was excellent for bathing parties and picnics, but has not enough freeboard when the sea gets up. We have now had her decked in fore and aft with a four-inch combing all round, which makes her more seaworthy.

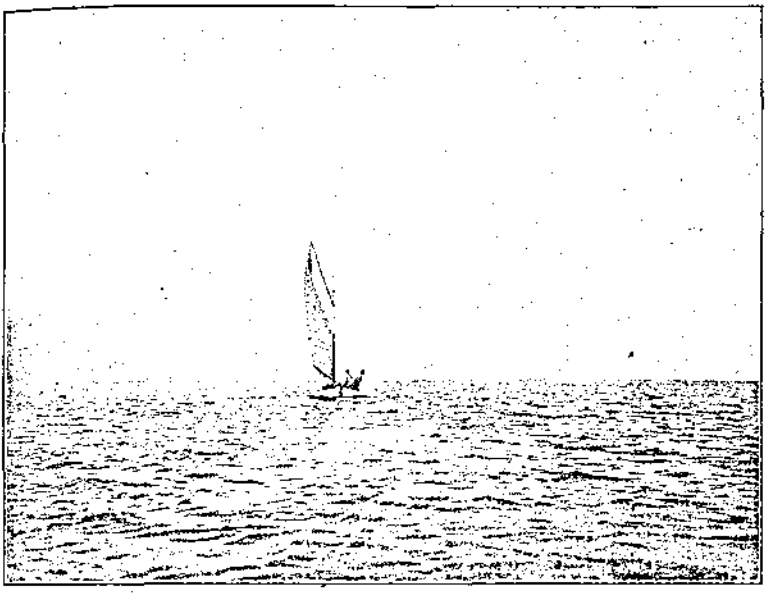
We took the yacht down to the Wular at the beginning of June, and raced nearly every afternoon against the three other boats of the same class belonging to Major Grace and Col. Biddulph. We were lucky enough to win more than half the races with the advantage of course of a new set of sails and a lighter hull, as the deodar had not absorbed its full amount of water.

We made many mistakes, from allowing the peak to drop too much to rounding the buoys badly, but looking back, I think we lost more by failing to trim the boat correctly than from any other cause. It was not till towards the end of the month that we discovered that a lee helm could be changed to a windward helm by shifting the live ballast forward two or three feet. We never looked once to see if the transom was dragging too low in the water, which I think now with these boats is one of the most important points to guard against.

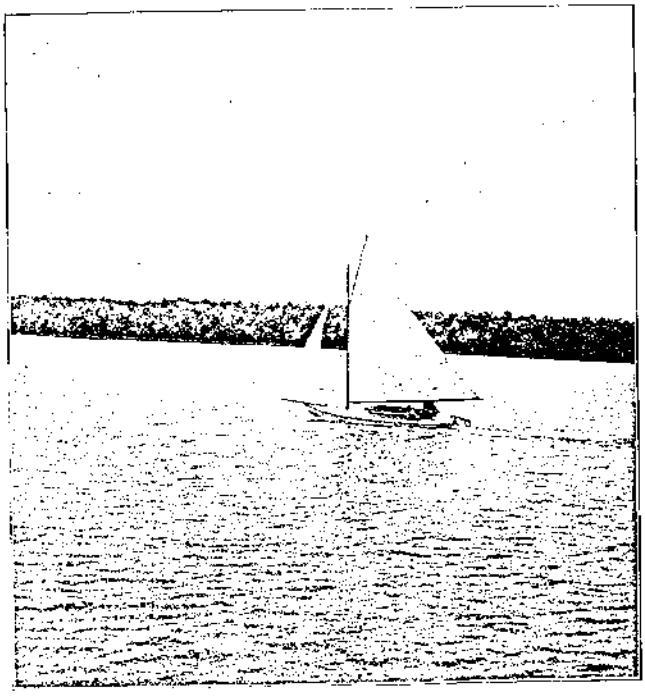
Next year, though, I hope we shall do better.


WULAR LAKE
The Madmatti is navigable to house boats as far as the log boom, about two miles. Open fields all round with a few trees good camping free from mosquitos in August.
Gilgit Road
MADMATTI RIVER
Log Boom
BUNDIPORE
ERIN NULLAH
Path runs via: Erin Nullah to Gungabal and Haramuk for pack ponies.
Good place for house boat at Cunis & wallab mosquitos in August.
Camp site marked x near Zurimanz – free from mosquitos all the year round.
Cunis
Cunis point
Ruined Hindu temple and Mohamedan Masjid
Lank
Wallab
Zurimanz.
5173
Weed
Wallab point
"Dead dog corner" Anything floating down the Jhelum collects here.
Kutcha Road to Sopor fit for motors.
Sopor 5 Miles
P1
P2
P3
P4
P5
weed
Weed
Jhelum River
Kutcha Road to Srinagar just possible for Cars.
Srinagar 20 Miles
Sopor 2 Miles
Ningle forest bungalow
Ningle — very good place for house boats – forest bungalow & kutcha road from Sopor. Major Grace had his boats here this year moored at mouth of River. mosquitos bad July & August.
5. Starting buoy
3&4 First racing buoys
1&2 Subsequent sites for buoys
Canal joins Jhelum short cut to Ningle.
Manisbal Lake very pretty worth seeing
Highgam Jheel.
Highgam is the main feeding ground of the duck, but is reserved for the Maharajah. Good shooting at dawn & dusk from the weeds to the north during Sept. & Oct.
Jhelum river runs between 1 and two knots Light doongas take 24 hours downstream & house boats 36 from Srinagar.
Baramullah
Turning to Sopor mile 106. Nor bad site for house boats just up stream of Sopor on right bank free from mosquitos.
Srinagar
SCALE
Furlongs 8 4 2 1 0 1 2 3 4 5 6 7 Miles

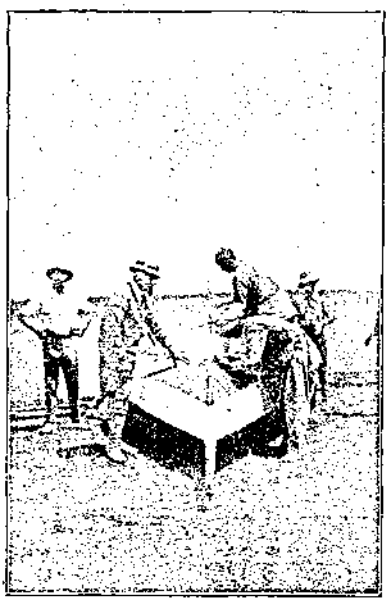
YACHTING IN KASHMIR.

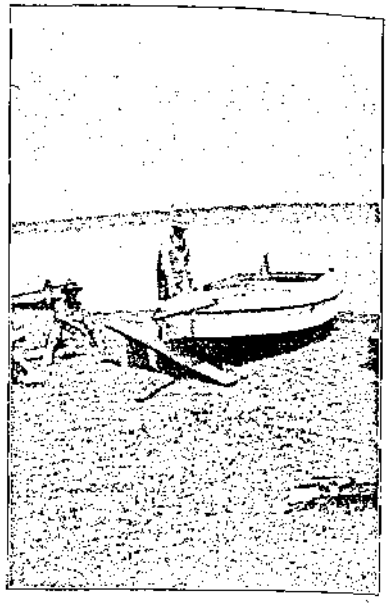


1.—A Light Breeze.

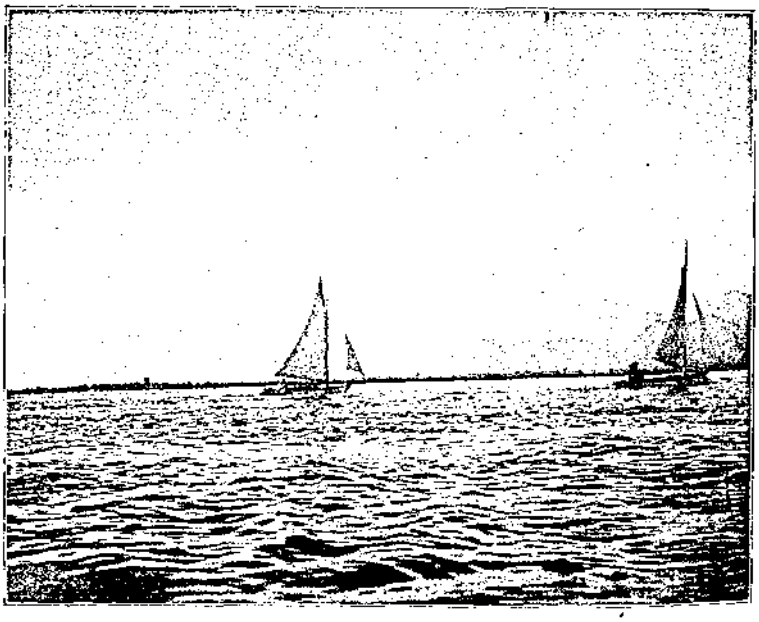


2.—Passing Ningle.





3 and 4.—Repairs at Ningle, showing the lines of the Boat.



5.—More wind coming.

BATTLE HONOURS OF ROYAL ENGINEER UNITS.

(*Continued*).

VALENCIENNES. 1ST TO 2ND NOVEMBER, 1918.

Unit.	Formation.	Remarks.	
FIRST ARMY			
ARMY TROOPS.			
25th Army Troops Co.		N.E.	
217th "	XXII Corps	"	
230th "		"	
282nd "		"	
568th "	XXII Corps	"	
1st Can. "	Can. Corps	"	
2nd Can. "	"	"	
3rd Can. "	"	"	
4th Can. "	"	D.	
5th Can. "	"	N.E.	
172nd Tunnelling Co.	XXII Corps	E.	
175th "	"	D.	No diary.
179th "	"	"	
XXII CORPS.			
9th Field Co.	4th Div.	D.	
406th "	"	E.	
526th "	"	"	
67th "	11th Div.	D.	
68th "	"	"	
86th "	"	"	
57th "	49th Div.	E.	
456th "	"	"	
458th "	"	"	
416th "	56th Div.	D.	
512th "	"	"	
513th "	"	"	
CANADIAN CORPS.			
1st Bn. 1st Bde. C.E.	1st Can. Div.	E.	
2nd "	"	N.E.	
3rd "	"	E.	
7th Bn. 3rd Bde. C.E.	3rd Can. Div.	"	
8th "	"	N.E.	
9th "	"	E.	
10th Bn. 4th Bde. C.E.	4th Can. Div.	"	
11th "	"	"	
12th "	"	"	
THIRD ARMY.			
ARMY TROOPS.			
547th Field Co. (73rd Div.)	XVII Corps	N.E.	
549th "	"	"	
232nd Army Troops Co.	"	"	
No. 2 Siege Co. R.A.R.E.	"	D.	
177th Tunnelling Co.	"	E.	
178th "	"	"	
XVII CORPS			
81st Field Co.	19th Div.	D.	
82nd "	"	N.E.	
84th "	"	"	

VALENCIENNES. 1ST TO 2ND NOVEMBER, 1918.

Unit.	Formation.	Remarks.
103rd ,,	24th Div.	N.E.
104th ,,	,,	,,
129th ,,	,,	,,
476th ,,	61st Div.	E.
478th ,,	,,	,,
479th ,,	,,	,,

SIGNALS.

VALENCIENNES. 1ST TO 2ND NOVEMBER, 1918.

Unit.	Formation.	Remarks.
First Army Signal Co.		N.E.
Y Corps Signal Co.	XXII Corps	,,
4th Div. Signal Co.	,,	E.
11th ,,	,,	D.
49th ,,	,,	E.
56th ,,	,,	D.
Can. Corps Signal Co.	Can. Corps	N.E.
3rd Can. Div. Signal Co.	,,	E.
4th ,,	,,	,,
Third Army Signal Co.		N.E.
R Corps Signal Co.	XVII Corps	,,
19th Div. Signal Co.	,,	D.
24th ,,	,,	N.E.
61st ,,	,,	E.

SAMBRE. 4TH NOVEMBER, 1918.

Unit.	Formation.	Remarks.
FIRST ARMY.		
ARMY TROOPS.		
"A" Special Co.	XXII Corps	N.E.
"B" ,,	,,	,,
217th Army Troops Co.	,,	,,
568th ,,	,,	,,
1st Can. ,,	Can. Corps	,,
2nd Can. ,,	,,	,,
3rd Can. ,,	,,	,,
4th Can. ,,	,,	,,
5th Can. ,,	,,	,,
172nd Tunnelling Co.	XXII Corps	D.
175th ,,	,,	,, No diary.
179th ,,	,,	N.E.
XXII CORPS.		
67th Field Co.	11th Div.	E.
68th ,,	,,	,,
86th ,,	,,	,,
416th ,,	56th Div.	,,
512th ,,	,,	,,
513th ,,	,,	,,
CAN. CORPS.		
7th Bn. 3rd Bde. C.E.	3rd Can. Div.	N.E.
8th ,,	,,	,,
9th ,,	,,	,,
10th Bn. 4th Bde. C.E.	4th Can. Div.	,,
11th ,,	,,	,,
12th ,,	,,	,,

SAMBRE. 4TH NOVEMBER, 1918.

Unit.	Formation.	Remarks.
THIRD ARMY.		
ARMY TROOPS.		
"N" Special Co.	V Corps	E.
"Q" ,,	IV ,,	,,
No. 3 ,,	IV ,,	,,
546th Field Co.	VI- ,,	N.E.
547th Field Co. (73rd Div.)	XVII ,,	,,
549th ,,	XVII ,,	,,
132nd Army Troops Co.	VI ,,	,,
142nd ,,	IV ,,	,, No diary.
147th ,,	V ,,	E.
149th ,,	IV ,,	N.E.
232nd ,,	XVII ,,	D.
280th ,,	V ,,	E.
559th ,,	V ,,	D.
565th ,,	VI ,,	,, No diary.
577th ,,	IV ,,	N.E.
No. 7 R. Mon. ,,	IV ,,	,,
No. 2 Siege Co. R.A. R.E.	XVII ,,	D. No diary.
No. 4 Siege Co. R.M. R.E.	V ,,	E.
174th Tunnelling Co.	VI ,,	N.E.
177th ,,	XVII ,,	E.
178th ,,	XVII ,,	,,
181st ,,	VI ,,	,,
183rd ,,	V ,,	,,
252nd ,,	IV ,,	,,
258th ,,	IV ,,	N.E.
N.Z. ,,	IV ,,	,,
IV CORPS.		
59th Field Co.	5th Div.	E.
491st ,,	,,	,,
527th ,,	,,	,,
152nd ,,	37th Div.	,,
153rd ,,	,,	,,
154th ,,	,,	,,
1st N.Z. ,,	N.Z. Div.	,,
2nd N.Z. ,,	,,	,,
3rd N.Z. ,,	,,	,,
V CORPS.		
77th Field Co.	17th Div.	E.
78th ,,	,,	,,
93rd ,,	,,	,,
97th ,,	21st Div.	,,
98th ,,	,,	,,
126th ,,	,,	,,
11th ,,	33rd Div.	D.
212th ,,	,,	,,
222nd ,,	,,	E.
123rd ,,	38th Div.	,,
124th ,,	,,	,,
151st ,,	,,	,,
VI CORPS.		
55th Field Co.	Guards Div.	E.
75th ,,	,,	,,
76th ,,	,,	,,
5th ,,	2nd Div.	,,
226th ,,	,,	,,
483rd ,,	,,	,,

SAMBRE. 4TH NOVEMBER, 1918.

Unit.	Formation.	Remarks.
56th "	3rd Div.	D.
438th "	"	N.E.
529th "	"	E.
457th "	62nd Div.	"
460th "	"	"
461st "	"	"
XVII CORPS.		
81st Field Co.	19th Div.	E.
82nd "	"	"
94th "	"	"
103rd "	24th Div.	"
104th "	"	"
129th "	"	"
FOURTH ARMY.		
ARMY TROOPS.		
648th Field Co.	IX Corps	N.E.
144th Army Troops Co.	XIII "	"
146th "	IX "	"
213th "		"
216th "	IX Corps	"
221st "	IX "	"
238th "	IX "	"
283rd "	XIII "	E.
288th "	XIII "	D.
567th "	IX "	E.
574th "		D. No diary.
No. 1 Siege Co. R.A.R.E.	XIII "	N.E.
No. 4 "	IX "	"
180th Tunnelling Co.	XIII "	E.
182nd "	XIII "	"
253rd "	IX "	N.E.
254th "	IX "	"
256th "	IX "	"
1st Aust. "	IX "	D.
IX CORPS.		
23rd Field Co.	1st Div.	E.
26th "	"	"
409th "	"	"
206th "	32nd Div.	"
218th "	"	"
219th "	"	"
465th "	46th Div.	"
466th "	"	"
468th "	"	"
XIII CORPS.		
79th Field Co.	18th Div.	E.
80th "	"	"
92nd "	"	"
105th "	25th Div.	"
106th "	"	"
130th "	"	"
7th "	50th Div.	"
446th "	"	"
447th "	"	"
430th "	66th Div.	D.
431st "	"	"
432nd "	"	"

SIGNALS.

SAMBRE. 4TH NOVEMBER, 1918.

Unit.	Formation.	Remarks.
First Army Signal Co.		N.E.
Y Corps Signal Co.	XXII Corps	D.
11th Div. Signal Co.	,,	E.
56th ,,	,,	,,
Can. Corps Signal Co.	Can. Corps	N.E.
3rd Can. Div. Signal Co.	,,	,,
4th ,,	,,	,,
Third Army Signal Co.		
2nd Signal Sqn.	2nd Cav. Div.	,,
D. Corps Signal Co.	IV Corps	,,
5th Div. Signal Co.	,,	D.
37th ,,	,,	E.
N.Z. ,,	,,	,,
O. Corps Signal Co.	V Corps	,,
17th Div. Signal Co.	,,	D.
21st ,,	,,	E.
33rd ,,	,,	,,
38th ,,	,,	,,
F. Corps Signal Co.	VI Corps	,,
Guards Div. Signal Co.	,,	N.E.
2nd ,,	,,	D.
3rd ,,	,,	E.
62nd ,,	,,	,,
R. Corps Signal Co.	XVII Corps	,,
19th Div. Signal Co.	,,	,,
24th ,,	,,	N.E.
Fourth Army Signal Co.		
E. Corps Signal Co.	IX. Corps	D.
1st Div. Signal Co.	,,	E.
32nd ,,	,,	,,
46th ,,	,,	D.
N. Corps Signal Co.	XIII Corps	,,
18th Div. Signal Co.	,,	E.
25th ,,	,,	,,
50th ,,	,,	,,

PURSUIT TO MONS. 28TH SEPTEMBER TO 11TH NOVEMBER, 1918.

Unit.	Formation.	Remarks.
CAVALRY CORPS.		
1st Field Sqn.	1st Cav. Div.	E.
2nd ,,	2nd ,,	,,
3rd ,,	3rd ,,	,,
FIRST ARMY.		
ARMY TROOPS.		
A Special Co.	XXII Corps	E.
B ,,	XXII ,,	,,
E ,,	XXII ,,	,,
F ,,	VIII ,,	,,
G ,,	XXII ,,	,,
O ,,	VIII ,,	,,
25th Army Troops Co.		,,
217th ,,	XXII Corps	,,
230th ,,		,,
282nd ,,		,,
568th ,,	XXII Corps	,,
1st Can. ,,	Can. Corps	,,
2nd ,,	,,	,,
3rd ,,	,,	,,
4th ,,	,,	,,
5th ,,	,,	,,

PURSUIT TO MONS. 28TH SEPTEMBER TO 11TH NOVEMBER, 1918.

Unit.	Formation.		Remarks.
No. 1 Siege Co. R.M.R.E.	VIII Corps	,,	
176th Tunnelling Co.	VIII ,,	,,	
179th ,,	XXII ,,	,,	
185th ,,	VIII ,,	,,	
VIII Corps.			
2nd Field Co.	8th Div.	,,	
15th ,,	,,	,,	
490th ,,	,,	,,	
83rd ,,	20th Div.	,,	
84th ,,	,,	,,	
96th ,,	,,	,,	
503rd ,,	58th Div.	,,	
504th ,,	,,	,,	
511th ,,	,,	,,	
Can. Corps.			
1st Bn. 1st Bde. C.E.	1st Can. Div.	N.E.	
2nd ,,	,,	E.	
3rd ,,	,,	N.E.	
4th Bn. 2nd Bde. C.E.	2nd Can. Div.	E.	
5th ,,	,,	,,	
6th ,,	,,	,,	
7th Bn. 3rd Bde. C.E.	3rd Can. Div.	N.E.	
8th ,,	,,	E.	
9th ,,	,,	N.E.	
Second Army.			
Army Troops.			
II Special Co.	X Corps	E.	
No. 4 ,,	,,	,,	
411th Field Co.	,,	D.	No diary.
550th ,,	,,	N.E.	
134th Army Troops Co.	XIX ,,	E.	
136th ,,	XV ,,	,,	
141st ,,		,,	
167th ,,	X Corps	,,	
236th ,,		D.	No diary.
245th ,,	XIX Corps	E.	
554th ,,	II-XV ,,	,,	
573rd ,,		,,	
171st Tunnelling Co.		D.	Diary useless.
255th ,,	II Corps	,,	No diary.
3rd Can. ,,	XV ,,	E.	
XV Corps			
224th Field Co.	40th Div.	E.	
229th ,,	,,	,,	
231st ,,	,,	N.E.	
Third Army.			
Army Troops.			
J Special Co.	VI Corps	N.E.	
K ,,	V ,,	,,	
546th ,,	VI ,,	,,	
547th Field Co. (73rd Div.)	XVII ,,	E.	
549th ,,	XVII ,,	,,	
232nd Army Troops Co.	XVII ,,	,,	
565th ,,	VI ,,	D	No diary.
577th ,,	IV ,,	E.	
7th R. Mon. ,,	IV ,,	,,	
No 2 Siege Co. R.A.R.E.	XVII ,,	D.	No diary.
258th Tunnelling Co.	IV ,,	E.	
N.Z. ,,	IV ,,	,,	

PURSUIT TO MONS. 28TH SEPTEMBER, TO 11TH NOVEMBER, 1918.

Unit.	Formation.		Remarks.
XVII CORPS.			
410th Field Co.	52nd Div.	E.	
412th ,,	,,	,,	
413th ,,	,,	,,	
421st ,,	57th Div.	,,	
502nd ,,	,,	,,	
505th ,,	,,	,,	
247th ,,	63rd Div.	,,	
248th ,,	,,	,,	
249th ,,	,,	,,	
FOURTH ARMY.			
ARMY TROOPS.			
D Special Co.	XIII Corps	N.E.	
Z ,,	Aust. ,,	,,	
No. 1 ,,	IX ,,	E.	
No. 2 ,,	Can. ,,	,,	
648th Field Co.	IX ,,	,,	
213th Army Troops Co.		,,	
216th ,,	IX Corps	,,	
221st ,,	IX ,,	,,	
238th ,,	IX ,,	,,	
570th ,,		D.	No diary.
1st Aust. ,,	Aust. Corps	E.	
No. 1 Siege Co. R.A.R.E.	XIII ,,	,,	
No. 4 ,,	IX ,,	,,	
253rd Tunnelling Co.	IX ,,	,,	
254th ,,	IX ,,	,,	
III CORPS.			
69th Field Co.	12th Div.	E.	
70th ,,	,,	,,	
87th ,,	,,	,,	
AUST. CORPS.			
1st Aust. Field Co.	1st Aust. Div.	N.E.	
2nd ,,	,,	,,	
3rd ,,	,,	,,	
5th ,,	2nd Aust. Div.	E.	
6th ,,	,,	,,	
7th ,,	,,	,,	
9th ,,	3rd Aust. Div.	,,	
10th ,,	,,	,,	
11th ,,	,,	,,	
4th ,,	4th Aust. Div.	N.E.	
12th ,,	,,	,,	
13th ,,	,,	,,	
8th ,,	5th Aust. Div.	E.	
14th ,,	,,	,,	
15th ,,	,,	,,	
FIFTH ARMY.			
ARMY TROOPS.			
C Special Co.	I Corps	E.	
M ,,	XI ,,	,,	
42nd Army Troops Co.	XI & III Corps	,,	
133rd ,,		,,	
135th ,,		,,	
148th ,,	III Corps	,,	
215th ,,	,,	,,	

PURSUIT TO MONS. 28th September to 11th November, 1918.

Unit.	Formation.	Remarks.
239th "		E.
281st "		"
284th "		"
290th "		"
552nd "	XI Corps	"
560th "		"
170th Tunnelling Co.	III Corps	"
250th "	XI "	"
251st "	XI & III Corps	"
257th "		"
3rd Aust. "	I Corps	"
I Corps.		
73rd Field Co.	15th Div.	E.
74th "	"	"
91st "	"	"
155th "	16th Div.	"
156th "	"	"
157th "	"	"
419th "	55th Div.	"
422nd "	"	"
423rd "	"	"
XI Corps.		
517th Field Co.	47th Div.	E.
518th "	"	"
520th "	"	"
467th "	59th Div.	"
469th "	"	"
470th "	"	"
5th Field Co. R.A.R.E.	74th Div.	"
5th Field Co. R.M.R.E.	"	"
439th Field Co.	"	"

SIGNALS.

PURSUIT TO MONS. 28th September to 11th November, 1918.

Unit.	Formation.	Remarks.
Cav. Corps Signal Sqn.	Cav. Corps	E.
1st Signal Sqn.	1st Cav. Div.	"
2nd "	2nd "	"
3rd "	3rd "	"
1st Army Signal Co.	1st Army	"
S Corps Signal Co.	VIII Corps	"
8th Div. Signal Co.	"	"
20th "	"	"
58th "	"	"
Y Corps Signal Co.	XXII Corps	"
Can. Corps Signal Co.	Can. Corps	"
1st Can. Div. Signal Co.	"	"
2nd "	"	"
2nd Army Signal Co.	2nd Army	"
X Corps Signal Co.	X Corps	"
P Corps Signal Co.	XV Corps	"
40th Div. Signal Co.	"	"
3rd Army Signal Co.	3rd Army	"

SIGNALS.

PURSUIT TO MONS. 28TH SEPTEMBER TO 11TH NOVEMBER, 1918.

Unit.	Formation.	Remarks.
D Corps Signal Co.	IV Corps	E.
O "	V "	"
F "	VI "	"
R "	XVII "	"
52nd Div. Signal Co.	"	"
57th "	"	"
63rd "	"	"
4th Army Signal Co.	4th Army	N.E.
C Corps Signal Co.	III Corps	E.
12th Div. Signal Co.	"	"
46th "	IX Corps	"
N Corps Signal Co.	XIII "	"
Aust. Corps Signal Co.	Aust. Corps	N.E.
1st Aust. Div. Signal Co.	"	"
2nd "	"	E.
3rd "	"	"
4th "	"	N.E.
5th "	"	E.
5th Army Signal Co.	5th Army	"
A Corps Signal Co.	I Corps	"
15th Div. Signal Co.	"	"
16th "	"	"
55th "	"	"
L Corps Signal Co.	XI Corps	"
47th Div. Signal Co.	"	"
59th "	"	"
74th "	"	"

A CONTEMPORARY ACCOUNT OF THE BATTLE OF GUJERAT.

By the LATE MAJOR-GENERAL SIR ALEXANDER CUNNINGHAM, K.C.I.E., C.S.I.

In forwarding the following account of the Battle of Gujerat, Lieut. Colonel Allan J. C. Cunningham (late R.E.) writes as follows:— "Among the papers of my father (the late Major-General Sir Alexander Cunningham) I have found the enclosed original account by him of the Battle of Goojrat. He was present as an Assistant Field Engineer at that battle, and drew up this report soon after. The original was prepared for Lord Gough: the present text is a copy in my mother's handwriting of that original. The plan is in my father's own hand. I send it now for publication in the *R.E. Journal*."

This battle, the final and decisive defeat of the Sikhs under Chutter Singh and his son Sher Singh, was fought on the 21st February, 1849. After the ghastly failure of the attack in the jungles of Chillianwalla on the 13th January, there was a deadlock of a month's duration, during which the two forces remained in close contact, and troops were hurried up to reinforce Lord Gough's army. The complicated problem of what to do next was fortunately solved for the British on the 12th February, when the Sikhs abandoned their formidable defences, probably through want of supplies, and took up a line in the open country covering the sacred city of Gujerat, and threatening the Chenab ford at Wazirabad and the road to Lahore. The British army followed leisurely, picking up its reinforcements on the way, and on the 21st, with a force of 4 Divisions and 4 Cavalry Brigades, attacked the Sikh Army, numbering 50,000 men with 59 guns, with the results shewn in the text. The battle was won by the guns, but the attack on Burra Kabra by Penny's Brigade, which is only lightly mentioned in this account, was a strenuous affair which cost the Brigade more than 300 casualties.

The services of General Cunningham are thus mentioned by the Chief Engineer, Brigadier Sir John Cheape, K.C.B., in his despatch, dated from Head Quarters, Camp Goojerat, February, 26th, 1849.... "I have also the gratification to report to his Excellency the zealous and able manner in which Captain Cunningham and Lieutenant C. Paton performed the duty assigned to them, of bringing up the

fleet of boats ordered by his Excellency from Ramnugger, and placing them so as to enable the portion of the army on the other side of the Chinab to co-operate and to come up : the former officer arrived before the close of the action and joined Brigadier-General Campbell's division. . . ."

F.E.G.S.

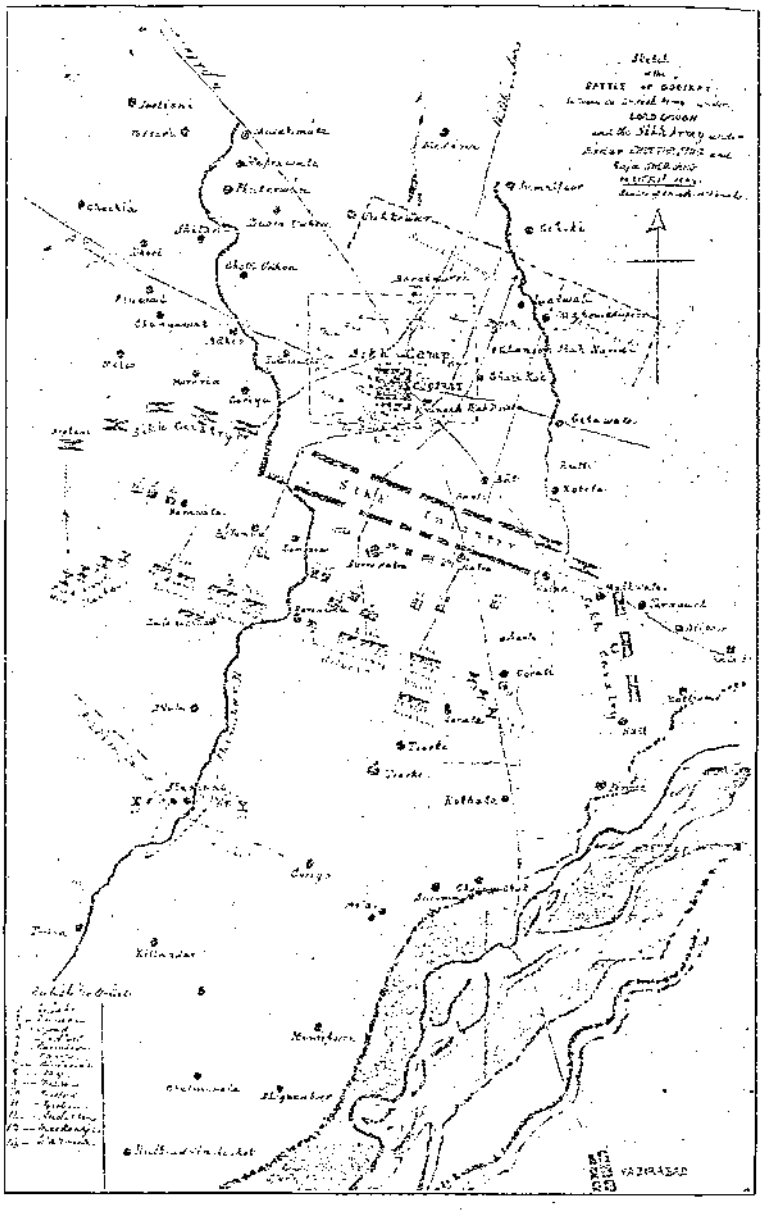
ACCOUNT OF THE BATTLE OF GOOJRAT.

On the 20th of February the British Army was encamped at Shadiwal, within 6 miles of Goojrat, to the S.S.W. On the morning of the 21st, the whole force, not more than 15,000 men, was under arms with 88 pieces of Artillery, 18 being heavy guns. The Army advanced in columns of Divisions at deploying distance as far as the village of Hariawala. A few shots had been fired at our reconnoitring parties, and at our Horse Artillery Batteries, which had been thrown forward to feel where the enemy's guns were posted by drawing their fire. The first shots were fired at 8 o'clock, and at 5 minutes before 9, our batteries having been pushed forward, the action commenced by a general discharge from all our guns, which was quickly answered by the Sikh guns.

The C.-in-C. was posted on the top of a house in the village of Hariawala—from whence he could see the whole of the Sikh position. Their advanced lines of infantry were lying down in shallow trenches, dug with the *bayonet* and scooped out *with the hand*. These afforded little, if any, cover against round shot. Their second lines of infantry were posted at some distance, and were mostly seated or lying down. Officers on horseback could be seen riding backwards and forwards, apparently for the purpose of giving orders and of encouraging their men to remain quiet.

After about one hour's firing our batteries were advanced about 300 yards. The infantry made a corresponding advance and each Division took ground to the right or left to avoid the roundshot from the enemy's batteries which had passed our own guns. These could not be altogether avoided, for the Sikh Artillery men turned their guns near Middle Kabra, so as to bring a raking fire upon our heavy batteries (VIII and X). (It was one of these raking shots which lodged in the calf of young Hutchinson's leg, close to the nullah in front of No. VI Battery). Our practice from the second position was beautiful, the shells fell amongst the infantry and dispersed them to the right and left, and the 18-pounder shot went lobbing along up to the suburbs of Goojrat *beyond* the brick kilns, where I counted 17 dead men and 2 wounded men, all hit by round shot. The heavy fire effectually broke the centre of the Sikh position—which was almost deserted, excepting by the Artillery men, and by some infantry in the villages of Burra Kabra and Middle Kabra.

In the meantime the enemy's Cavalry had advanced and threatened both our flanks—on our right the wet nullah, about 6 feet deep and feet (*sic*) broad with steep clay banks, effectually protected our flank—and allowed Warner's battery to play upon the



head of the advancing party within good range. On our left the Afghan Horse advanced, apparently with the intention of getting to our rear, but the spirited charge of the Scind Horse (ordered by

Thackwell) and a few shots from Huish's guns soon sent them flying in great disorder, leaving one man of rank and many others on the field. In the centre a small party of daring men, about 40, dashed between Lane's guns, towards the C.-in-C. These were engaged by individual Officers and by the small escort of Nat. Cavalry under Stannus, and they were all eventually cut up or shot. Cocks, of the C.S., and Major Campbell, 53rd. N.I., were wounded by these men. They had apparently devoted their lives to some object. On one horse there were two men seated back to back! (facing both ways).

A second advance of our line, preceded by the guns, which opened at a sure distance, soon drove the enemy from their position, excepting from the villages of Burra Kabra and Middle Kabra—which were carried by Penny's Brigade (2nd Eur., 31, 70, N.I.) and by Hervey's Brigade (10th Queens,* 8, 52, N.I.) with considerable loss.

At the first Sikh Battery on the nullah there were two daring men who continued to fire an 18-pounder gun (a highly ornamented piece made in 1803 by Mazafar Khan) for fully half-an-hour after the other guns of the Battery had been silenced. They were dressed in red coats, and must therefore have been infantry men trained to the work. The whole army advanced and halted (in the position of the rear line of Sikh infantry). The Sikhs fled towards Goojrat followed by the Cavalry and Horse Artillery. The Army again advanced, the 4th Division in line to the left of Goojrat, the 3rd and 2nd Divisions in column and the 1st Division in line to the right of Goojrat. The enemy's Cavalry on their right fled past the Barahdurri, and took the Bhimbar road. Our line again advanced, passing by the Sikh Camp, which the Camp followers plundered in fine style. Horses, camels, and Bullocks were laden with tents, *satrinjis*, beds, boxes, clothes and arms of all kinds. The troops marched steadily past, and the enemy's camp was soon in flames from the blowing up of large *dubhas* of powder.

As our line advanced we came upon the enemy's guns and ammunition carts which had been abandoned—and we found the whole country covered with baggage and wounded men. We halted and encamped bejond Goojrat on the Bhimbar road. Our Cavalry and Horse Artillery continued the pursuit for 12 miles, by which we captured 9 guns, and an immense quantity of ammunitien and baggage.

The enemy lost about 700 killed on the field of battle (I have counted 420, and I have not been over the scene of the Afghans' defeat, nor over many other parts of the field) and they must have lost about double that number of killed in the pursuit, or say 2,000 killed—their wounded may be about the same number. Our

* Her Majesty's 10th Foot.

loss was 800, of whom about 300 were so slightly hurt that they will return to their duty during the present month.

On the 22nd, General Gilbert with two divisions of the army marched towards Jehlam and General Campbell with one Division towards Bhimbar, while the Cavalry were sent to scour the country; nine more guns were picked up in one place and two more in a second place, making a total of 53 captured pieces, of which two were our own—one being Lane's gun lost at Ramnagar, and the other being one of Huish's lost at Chelian.

The Sikh Army was completely broken by their defeat. They lost 53 guns out of 59, and their infantry were obliged to throw away their arms and accoutrements and disperse. All our camp followers are now armed with matchlocks, muskets and tulwars.

The Afghan horse took the direct road to Jehlam via Korian, and arrived there at 5 o'clock on the same evening. Sher Sing and Chutter Sing with the main body fled towards Bhimbar, and did not reach Jehlam until the next day at 12 o'clock. No more than 4,000 infantry could be assembled with 17 or 18 guns. Most of the guns had been kept there by Aotar Jing, who remained on the line of the Jehlam.

In this account I do not think that I have omitted anything material. The day was beautifully fine and the snowy peaks of the Kashmirian hills (the Pirpanjal) shone with dazzling brilliance in our front. The whole battle was a field day, with the excitement of real action, and no bewilderment from loss of temper or angry words.

A COLONIAL SURVEY SECTION, R.E., IN MALAYA, 1923-26.

By CAPT S. WOODBURN KIRBY, O.B.E., M.C., R.E., and LIEUT. J. C. T. WILLIS, R.E.

(A) HISTORY OF THE COLONIAL SURVEY SECTION.

The Colonial Survey Section is one of those small units which are produced from time to time by the Corps, which appear in no *War Establishments*, have no definite size or shape, and no continued existence. It has, however, a tradition, holds the world's record for economical mapping, and is the best of training grounds for war surveys. The survey of a certain area is required, a Section comes quietly into being, the job is done and the Section as quietly disappears, with the work it has done as the only sign that it ever existed at all.

Such a Section usually consists of one Captain, one Subaltern and five N.C.O's., a combination of officers and tradesmen which has been proved to give the best results both in technical efficiency and ease of administration.

The maps produced by these Sections have as their ideal "the best possible," and they have proved themselves in the past to be as good as enthusiasm, skill and good instruments can make them.

Colonial Survey Sections have in the past 25 years been sent to various parts of the world such as Mauritius, St. Helena, the Orange Free State, Malaya Command, Hong Kong, and many of the maps published by the Geographical Section, General Staff, are the fruits of these labours.

This is neither the time nor the place to discuss how or why the Colonial Survey Section which sailed to Malaya in 1923 came into being. It suffices to say that it commenced work in Johore at the southern extremity of the Malayan peninsula in October, 1923, and is still at the moment of writing working in Johore.

(B) TECHNICAL AND ADMINISTRATIVE INSTRUCTIONS.

The Section was placed technically under the command of the Geographical Section of the War Office, and was instructed to survey in the first instance the south-east peninsula of Johore, with the ultimate object of mapping the whole of Johore south of the Batu Pengarrang-Mersing Road, with certain small exceptions. The decision as to the point at which the Survey commenced and which areas were to be surveyed on the 1/20,000 or 1in. scales was left to the

O.C. Section, in consultation with the General Staff, Malaya Command, subject to the approval of the War Office.

Further instructions covered the co-operation with His Majesty's Surveying Ship "Iroquois," which was charting the coasts of Johore. It was also proposed to send out aircraft during 1924 to photograph, amongst their other duties, those areas in Johore in which air photographs would be valuable as assistance to the topographer.

Administratively, the Section came under the control of the Malayan Command, who were instructed to give as free a hand as possible, for the nature of the work made it impossible to conform to the usual routine, especially where the Finance and Ordnance Branches were concerned.

(C) The F.M.S. Survey Department and Existing Data.

The Section was very fortunate in working in close co-operation with Mr. Lowinger, the present Chief of the F.M.S. Survey Department, on whose primary triangulation data the whole of the work of the Section was based. The F.M.S. Survey Department has long been in close touch in various ways with the Corps, a past Surveyor-General, Colonel Jackson, having been an officer of the Corps, while previous to the War another Section was working in Negri-Sembilan under the command of the late Captain Dunman, R.E. Thus it is not the first time, nor, may we hope, the last, that an R.E. Section has worked in close co-operation with a Surveyor trained in the South African School and in the methods of the late Sir David Gill.

The data with which we were provided consisted of a principal triangulation which covered the greater portion of Malaya and on which the existing topo. maps were based. In Johore these points are spaced at an average distance of 10-15 miles apart. In addition to this, the Johore Survey Revenue Branch had surveyed the boundaries of all plots of land alienated to private owners. These boundaries are marked by concrete stones or pillars, and the methods employed, theodolite traverses based on the primary trig., give an accuracy of approximately 1/2000. In addition, precise traverses have been carried along all the main roads and railways.

Such, therefore, was the existing control in south-east Johore, but before it could be used a certain amount of work had to be carried out, viz.,

(a) The principal trig. points had to be cleared of jungle growth, a task which might employ as many as 20 cutters for 10 days.

(b) The records of the Revenue work, which of course only existed in the more cultivated and developed areas, had to be examined, tracings made of the plots so as to enable the

boundary stones to be recognised, their co-ordinates obtained, and finally the boundary stones located on the ground.

The former required organisation, the second was very difficult, for the stones were hidden in the undergrowth, or in many cases had been removed by the Chinese landowners, or had their positions materially altered. It will be seen, therefore, that for accurate mapping they could not be relied upon without some check, and of course they were not 'heighted.'

(D) THE CLIMATE, AND DESCRIPTION OF THE COUNTRY.

Johore, now joined to the island of Singapore by a causeway, lies at the south of the Malayan Peninsula, and the backbone of mountains stops just on its northern boundary, reappearing in isolated hills only, which become smaller further south. Generally speaking, Johore is low-lying and undulating, the altitude except in the case of the isolated hills mentioned being seldom above 200 feet. In most cases where the Section was employed a cleared hill of over 300 ft. would command a view over almost the whole country, which lay spread out below the observer as an undulating stretch of dense green foliage. The rivers are slow and winding, and generally tidal for some long way from their mouths. Wherever a river is tidal, thick belts of mangrove, some 20-30 feet in height, line its banks.

On either side of the railway, main roads and navigable rivers, the jungle has given place to a belt of cultivated land where rubber, palm and pineapple have been planted.

The remainder of the country is virgin jungle, with the exception of the south-east peninsula, which, owing to previous cultivation many years ago, has large areas of secondary growth, consisting of dense undergrowth interwoven with every known type of creeper, and infinitely more difficult to survey than virgin jungle.

The climate of Malaya is tropical, the shade temperature is not extreme, varying between 80°-95°, but the high percentage of moisture in the air makes it extremely trying to live in.

There are two monsoons, the south-west from May to October, the north-east from October to March. Generally speaking, the north-east is the wet season and the south-west the dry. In Johore during the south-west monsoon there is rain nearly every day in the afternoon, with sudden tropical storms known as "Sumatras." During the north-east monsoon it may rain for three days on end, followed by a more or less fair period. During the changes of monsoons thunderstorms are prevalent.

It will thus be seen that in South Johore survey work could be carried on at any time of the year, whereas further north all field work had to cease for at least three months during the north-east monsoon, due to the far heavier rainfall which obtains there.

(E) PRELIMINARY WORK.

The Section disembarked at Singapore on the 5th October, 1923, and was accommodated in the R.E. Barracks at Pulau Brani while preliminary arrangements were being made. As can well be imagined, a great deal had to be accomplished before the field work could be started, as there existed no organisation for survey work, and but little knowledge of the country beyond the limits of Singapore Island. In fact, the most that the Section had as assets to start with were a general anxiety to help on the part of the local authorities, and a very free hand as to what arrangements it was about to make. The preliminary work fell into four headings :—

1. *Liaison with the Staff.*

At a conference held at Command Headquarters, it was decided :—

(a) to commence work at the southern end of the south-east peninsula of Johore, for not only did this meet the demands of the Staff, but also it was an easy starting point from a survey point of view, owing to the existence of three primary trig. points in the area, as well as a fair amount of Revenue work.

(b) that the surveys should be carried out on a scale of 1/20000 south of latitude 1° 45′ 00″ and east of meridian 103° (an area of some 750 sq. miles). The remainder of the area was to be surveyed at 1″ to the mile.

(c) The whole question of conventional signs was investigated, and after some discussion with the authorities at home, a suitable result was obtained.

2. *Liaison with the F.M.S. Survey Department.*

As soon as possible after landing, a visit was paid to the Surveyor General at Kuala Lumpur, the Capital of the Federated Malay States, and to the Officer-in-Charge of Topographical Surveys at Taiping. We were received with the greatest kindness and given every assistance. It was arranged that the same symbols should be used as were employed by the F.M.S. Survey Department, and that we should follow their methods of finishing-off the plane table sheets, so that each batch of field sheets could on completion be photographed at Kuala Lumpur prior to their despatch to England. This arrangement enabled the F.M.S. Survey Department to produce 1in. to the mile topo. maps from our 1/20,000 field sheets locally, and provided a duplicate in the event of any accident to the original on its way home.

The Surveyor General kindly offered the loan of an experienced *mandor* (head man) for the coolies, and to recruit the first batch of 50 Malays.

At Taiping, the Officer-in-Charge of Topographical Surveys gave the greatest assistance in all discussions connected with the methods adopted by his Department for use in various types of jungle and

cultivated country, and provided many hints from his lengthy experience of Malaya as to the handling of coolies, etc.

3. *Liaison with the Johore Government.*

A visit was paid to the British Adviser to H.H. The Sultan of Johore. Financial arrangements regarding the share of the Johore Government were concluded with him, and official permission was obtained to enter any part of the country, including all privately-owned ground. As the Section became better known and began work in the more developed country, we were greatly assisted by every department of the Johore Government, more especially the Police and Forestry Departments, with whom we worked in the very closest touch.

4. *General Administrative Arrangements.*

A glance at the map will show that the only means of communication in the south-east peninsula is by water, and although there was a Chinese-owned daily steamer, which maintained a slow and somewhat erratic service, much interfered with by Chinese festivals and the whims of the skipper, from Singapore to Kota Tinggi, it was considered necessary to be independent, and a motor launch about 24ft. in length and with a speed of 8 knots was purchased, as were certain small native craft for duty as dinghies.

The purchase of a motor launch in the native tongue, as yet imperfectly acquired, was fraught with many difficulties, and ended in the appearance of one of the Officers of the Section, in full uniform and sword, in the law courts to answer a charge of obtaining goods under false pretences. The incident, however, closed satisfactorily, the over-imaginative Malayan accuser receiving his just reward for his extensive perjury. The launch, though suffering in its later years from all the infirmities due to prolonged overwork, proved most useful, and ran some 10,000 miles during the first 18 months in our possession.

In addition, the following arrangements had to be made before the field parties could be started at work, viz., arrangements for the supply of food and drink for all Europeans, the supply of rice for the coolies, the clearing of existing trig. points, the collection and distribution of Revenue data, and the uncrating and checking of all the stores. All this was accomplished with some difficulty by the end of October, 1923, when the first batch of 50 coolies arrived from up country, and the "labour situation," the bugbear of the next three years, commenced in earnest.

The History of the Survey.

A start was made at the southern end of the south-east peninsula and the base was established at the foot of Pengerang Hill, on which a main F.M.S. trig. point was located. Each topographer was allotted

one quarter of a 15' square, an area of 18½ sq. miles, and set to work while the trig. scheme was being pushed ahead.

No great difficulty was found with the trig. work, which quickly forged sufficiently far ahead to provide the topographers with all the control they required. The field work, however, did not go so well, as the individual topographers had not only to be trained to the new methods, but had in addition to become acclimatised and learn to handle their coolies, by no means an easy task until they had obtained command of the language. Some attempt had been made by the officers to instruct the remainder of the party in the rudiments of the native tongue, no easy matter when the instructors themselves had great difficulty in keeping even one page in the grammar book ahead of their pupils.

The work was organised as follows during this period: the O.C. divided his time between the fixing of minor trig. control, the reconnaissance for the secondary trig., visits of inspection, advice, and in some cases consolation, to the field parties, and the entire administrative work. At the commencement it was impossible for the O.C. to be more than three weeks out of the month in the field, the remaining week being spent at headquarters, with perhaps one or two days a month in Singapore interviewing the Staff, arranging for food supplies, pay and recruitment of coolies, etc.

As time went on, the Section began to work further away from civilisation, and it became less possible for the O.C. to absent himself from headquarters. At least two days in every week and a whole week at the end of each month were fully occupied in the administrative work. After the increase in the strength of the Section matters became even worse, and except for occasional visits to the topo. parties and such trig. work as lay within 24 hours journey of headquarters, the computing, the air photo work, and the administration kept one officer tied to headquarters almost continually.

The other officer was employed at the start, and practically throughout the first year-and-a-half, on trig. work, having his own party of coolies and being away from headquarters for periods varying in length up to two months. During the last half of the period he was put in charge of the labour, including recruiting and the minor control.

The senior N.C.O. in the Section was employed at the commencement in training the four topographers, and providing them with control traverses until such time as they could stand on their own feet. He then undertook an area of his own. Throughout the three years he was in charge of the topographers, training all newcomers, supervising their work, testing different methods, and correcting mistakes.

It will be of interest to give an outline of the daily work of the field parties.

6.30 Breakfast.
7.30 Commence work in the field.
1.30 Return to camp. This hour varied according to the distance the work lay from camp and the weather, but each topographer usually averaged 6 hours a day in the field. The afternoon was spent in inking-in the day's work, plotting traverses, transferring work from auxiliary sheets to field sheets, etc.

Work continued throughout the week, topographers taking a day's rest whenever they so desired, usually one in every 10 days, and they came into headquarters once a month with their monthly accounts, if the distance and means of transport made it possible. One enthusiast tried the experiment of attaching an out-board motor on to a flimsy Malayan dugout. For a month it went well, until one night he left it unguarded too near a Chinese hut and it went altogether.

The area south of parallel 1° 26′ 30″ was completed by March, 1924, and the section then moved astride the river Lebam further north. Throughout our work in this area we received the greatest assistance and kindness from all the Japanese working on the neighbouring estates. Their hospitality and the assistance they rendered us in treating our sick coolies and admitting them to their hospitals leaves us much in their debt. The difficulty of conversing with them was overcome by the use of a pot-pourri of English, Malay, Japanese, and in one case, Russian.

The arrival of H.M.S. "Pegasus" made it necessary to move headquarters to a more centrally-placed spot from which touch could be kept with the airmen, whether they were in Singapore or in the Johore Strait, and where there was room to store the photographs and obtain an office. Another long-felt want was also met by the provision of a store, which enabled us to combat to some extent the ravages caused by white ants.

As a result headquarters were moved to Johore-Bahru, the capital of the State, where the Johore Government very kindly put an office at our disposal. This remained the headquarters for the next two years, sub-headquarters being opened at Kota Tinggi when the topographers were working in that neighbourhood. Kota Tinggi is a Chinese town of some 2,000 inhabitants and about six European rubber estate managers. In this town we secured a plot of land and erected five Attap sheds and staffed them with a caretaker.

On completion of the area astride the Lebam, the Section moved to Kota Tinggi, and thence gradually westwards, till the whole area on the larger scale was mapped.

It was at about this period of the survey that the trig. work became sufficiently far advanced to enable the officers of the Section to

review more carefully the methods employed by the topographers, and to organise the output of topo. work on a more satisfactory basis. Straight *rentis** cutting, referred to in para. 'H,' was introduced. Food supplies were organised on a monthly supply basis, routine trips of the launch were instituted, and many minor changes enabling the output to be increased, or the expenditure reduced, were put into practice as a result of the first year-and-a-half's experience. As the Section worked across westwards into more civilised areas, the amount of control provided by the Revenue stones was increased, and the value of the air photographs also began to make itself felt.

The value of this reorganisation was shown by the fact that it became possible for the two officers of the Section to control a much larger area under survey than previously, and it was obviously economical to attempt to obtain more N.C.O's., and with the number of field parties thus increased, to double the output of work for the same overhead and administrative costs. The additional N.C.O's. asked for, five in number, reached the Section in June, 1925, thus bringing the total strength up to two officers and ten N.C.O's.

It was at this time also that the Section began to be troubled with serious sickness. The climate began to take its toll, and malaria became very prevalent. Members of the Section had to be sent home to England on this account, and for long periods it was not possible to reckon on all the ten field parties being actually at work in the field.

It is worthy of note that the graph showing the area of map produced per man per month, after rising steeply at the commencement as each man became accustomed to his work, maintained a steady level of about 3-4 square miles a month, depending on the type of country, until the man had been working for 2½ years, after which it showed a steady drop, until on the completion of 3 years the man was relieved and returned to England. This drop was unquestionably due to the strain of working in a climate in which the shade temperature is seldom below 80° day or night, winter or summer.

At this juncture it may be as well to look into the various questions of "Quartermastering" which arose. It must be borne in mind that Johore is a country of little game, and it is impossible to "live on the land." Every article of food and drink, whether for European or native, must be transported by car, by dugout, or by coolie. It takes 4 men to carry sufficient food for one European for three weeks. An average monthly consumption of rice by the coolies was about 3 tons, much of which had to be delivered to exceedingly inaccessible places.

* *Rentis* is the Malay name for a pathway cut in the jungle sufficiently wide for a man to walk through.

A small grocer's shop was established by headquarters in Johore-Bahru, and the Section received the benefit of purchase in bulk. Finally it may not be out of place to reproduce here a circular sent round to the Section shortly before the departure of all the original members to England, on completion of their spell of duty.

"THE SURVEY MESSING ACCOUNT. OCTOBER 1923—SEPTEMBER, 1926.

It is considered that the following figures, representing goods supplied by the above account, will prove of interest to those who have helped to make the total what it is:—

Whiskey	.. ..	974 Bottles.
Vermouth	.. ..	416 ,,
Gin	.. .. ..	59 ,,
Cigarettes	.. ..	2,049 Tins (of 50).
Tobacco	.. ..	195 ,, (¼ lb.)

It is computed that the actual weight of alcohol, exclusive of corks, bottles and packing, is in the neighbourhood of one-and-a-half tons, while the cigarettes supplied, laid end to end, would reach a distance of 49.4 miles. The amount of money spent by the Section on drinks and tobacco through this account is over $4,200. What it costs to produce a map!"

CO-OPERATION WITH H.M.S. "IROQUOIS."

During the summers of 1924-26, H.M.S. "Iroquois" was engaged in charting the south and east coasts of Johore. It was arranged that whenever possible the Colonial Survey Section should site their trig. beacons with an eye to both sea and land surveys, so as to make it unnecessary for the Naval Surveyors to carry out a triangulation system of their own.

The naval surveying ships are not allowed to use native labour, nor are they equipped for undertaking heavy clearing work of this nature ashore. Arrangements were made whereby the Section did a certain amount of clearing and other work with native labour for the "Iroquois," who in their turn gave invaluable assistance in transporting both members of the Section and their coolies to such parts of the area as were not readily accessible by land. Thus the Services were working side by side and upon the same framework, to the considerable profit of the public purse.

CO-OPERATION WITH H.M.S. "PEGASUS."

(1) H.M.S. "Pegasus," carrying five seaplanes, arrived in Malaya in April, 1924, in order, amongst other duties, to take aerial photographs of Johore for survey purposes. Acting on instructions from home, the Officer Commanding, prior to the arrival of the aircraft, drew up a programme of photography covering the roads, railways,

rivers and coastline of the southern portion of Johore with numbered strips of photographs. Control Points were fixed which would enable these strips to be used for survey purposes, and they were marked in such a manner that they could be located on the actual photographs. The method of marking was as follows :—

A cross of white cloth was laid out on roughly constructed wooden trestles some 3 feet from the ground, the centre of the cross marking the actual point. The dimensions of each arm were approximately 4 by 1½ yards. This marking proved satisfactory in every way.

(2) The R.A.F were asked to take the photographs at a uniform height of 10,000 feet, with a fore and aft overlap of 50 per cent. and a lateral overlap where necessary of 25 per cent. Each strip was to start prior to reaching the control point and was to be flown straight without turns until the control point at the other end was reached. Tilt, both lateral and fore-and-aft, was to be avoided as far as possible.

(3) On this programme the aerial photography commenced, but after a few reconnaissance flights over the jungle area it became evident that air photographs of jungle itself would be of but small assistance to the surveyor, for streams, practically the only detail, did not show through the trees, and ground forms could not be recognised, even with the assistance of a stereoscope. Photography only showed the tops of the trees, which vary considerably in height. The programme was, therefore, revised. No work was done over purely jungle areas, and photography was confined to coastlines and rivers (where visible from the air), and to those areas which had been opened up for cultivation.

(4) The photographs were taken by the R.A.F., developed and one copy printed. This copy was forwarded to the O.C., Colonial Survey Section, who examined it to see whether the standard as regards clearness of photography, absence of tilt, maintenance of height and the area covered came within the given limits. If the strip was accepted for survey purposes it was then indexed and filed, and the R.A.F., on being informed, printed off a second copy.

The pilots were faced with many difficulties in obtaining photographs of the required standard. These difficulties included :—

(a) *Clouds.* Every morning at between 9 and 9.30 o'clock banks of clouds formed at a height of 2,000 feet, often reaching as high as 20,000 feet, over the land, with only occasional gaps. It thus became necessary to carry out the photography before approximately 9 o'clock. As the light prevented photography much before 8 o'clock, the amount of work that could be carried out each day was strictly limited ;

(b) Difficulties of recognising the commencement and the end of the strips ;

(c) Flying difficulties due to the climate, etc. In spite of all these difficulties the programme was completed by October, 1924, when H.M.S. "Pegasus" proceeded to Hong Kong. In February, 1925, H.M.S. "Pegasus" spent one month in Singapore on her return journey to England. A supplementary programme was undertaken, but the fact that the North-east monsoon was at its worst during this month made the completion of the programme impossible.

(5) The photographs were used for surveying purposes as follows :—

At first a compilation was produced from air photographs. As no topographical stereoscopes* were available, the following method was adopted. The individual photographs of strips were placed in their approximately correct positions by means of numerous control points (usually Revenue boundary stones). These control points were located on the photographs and an approximate scale for the strip determined. Bristol boards were then gridded on this scale, the control points plotted, and the individual photographs adjusted so that the control points gave the best fit. The photographs were then pasted down. The required detail was inked up in white and each strip reduced to the required scale by photography (using a half-tone screen), put down on zinc and copies printed off. The detail was then transferred from these copies to compilation sheets. The accuracy of these sheets was quite good in flat country, but the value of the compilation sheets as a whole did not come up to our hopes. We could in fact neither see inequalities of height through the dense foliage nor give any general value for the height of the trees. Even had such an estimate been possible the lack of proper stereoscopes referred to above would have made it impossible to use the photographs in any but a strictly perspective way. The Surveyor in the field had then to cover the whole area in order to secure his contours, and in doing so was enabled to survey his detail by ordinary methods with very little extra expenditure of time. Thus he received but little assistance from the compilation sheets.

He did, however, obtain (a) an uncontoured map showing the limits of cultivation, and the direction of the streams and their approximate position, which enabled him to organise in advance the work of his coolie cutting gang : (b) detail of mangrove areas which he could not very well enter without boats, and which were in certain cases very difficult to survey.

A plan of any area sufficiently accurate for the purpose of organising the work of the coolies could however be obtained by reductions from rough mosaics, and the mangrove area and coast line could

* An excellent model is now made for the Air Survey Committee by Messrs. Barr and Stroud. Details of this instrument will be found in a forthcoming professional paper by the Air Survey Committee on the stereoscopic examination of Air Photographs.

equally well be transferred to the map by the topographer himself using proportional compasses. For these reasons the compilation sheets were discontinued and separate photographs were issued to the topographers, who transferred what detail they required direct on to their field sheets (for details see paragraph "H").

(6) In conclusion, the visit of H.M.S. "Pegasus" to Johore proved that air photos for mapping purposes are of little value in a country clothed with dense tropical vegetation, except in those areas below the level of the lowest contour, where obviously the height of the vegetation can have no effect, and in the cultivated areas open to view from the air where the detail is intricate. It did prove however the general value of aircraft to the officer contemplating a topographical survey in a more or less unknown region.

Not only was the O.C. enabled to make a reconnaissance for the triangulation by air, but he was enabled to get a bird's eye view of areas previously unknown and unvisited which, besides saving him much expenditure of energy and of hard cash on the provision of boot leather, made it possible for the survey of these areas to be undertaken in the most efficient fashion.

On one occasion a trig. point on the sea coast, some 40 miles as the crow flies from Headquarters, and distant at least 2 days' journey by usual methods, was, thanks to the seaplane, visited and observed in one day, the officer who observed being absent from Headquarters only some 8 hours.

In the future it may be more or less normal for the sapper surveyor to fly to his next trig. point, to spot a lazy field party from the air, or, fortified by a cocktail, to make up his angle book in the wardroom of one of H.M. surveying ships—but this is certainly the first time on record where it has been actually done. The practice is recommended.

(G) LABOUR.

The provision of a suitable labour force was one of the greatest problems that had to be faced. The choice lay between the three races to be found in Malaya.

1. *Tamils.*

Tamils are imported under very strict Government regulation and supervision. Long spells of work must be guaranteed, as the law does not admit of the transference of Tamil coolies between different employers. It is also necessary to import a definite percentage of women at the same time, a factor which could scarcely have been expected to minimise our already numerous difficulties.

2. *Chinese.*

The Chinaman is ubiquitous in Malaya. He is present in every walk of life, from rich merchant to street hawker, but his chief role is that of a shopkeeper or a coolie. He is not versed in the ways

of the jungle, and he requires a more varied diet than any other native. He is therefore difficult to feed when out on long treks The wages which he commands are higher than any other coolie. and his language is frankly impossible. He will, however, attempt anything that has sufficient chance of profit to himself, and if once good wages are assured he will do as much work as any three Malays.

3. *Malays.*

The Malay, the real native of the country, is an extremely attractive gentleman, humorous and courteous, but centuries of an enervating climate and a soil which will produce sufficient for his needs with a minimum of effort has made him constitutionally lazy, full of malaria, and incapable of any consistent effort. His life of indolence is in most cases far beyond the temptation of money, and no matter what inducement is offered, he prefers to sit rather than stand. The F.M.S. Survey Department employs Malays, and recruits them from those parts of the country which have scarcely been touched by civilisation for the duration of their field season, about eight months. These areas have for many years produced all the Survey coolies required, men coming back each year at the commencement of the season; but these areas are small, and with the increasing spread of civilisation and the higher wages paid by the then prosperous rubber estates, with the added attraction of a coffee and bun shop round the corner, coolies for survey work become more and more difficult to obtain.

It was from this source that the Surveyor General recruited our first batch of coolies, but our requirements soon exceeded this figure, and it was found necessary to send the *mandor* to recruit a further batch. It was then found that we were in competition with the F.M.S. Survey Department, who took all the best men; in addition the coolies soon discovered that the white man as a topographer worked harder and faster than the native with whom they were used to survey, and that Johore was so far from their home that they could not conveniently run away when they got tired, their favourite solution to any problem or to any situation requiring sustained effort. It thus became more and more difficult to obtain coolies, especially as our requirements were continually expanding.

Both north and south Johore were tried, only to find that the native of these parts was out of his element in the jungle, disliked the work, and being near to his home, ran away at the first opportunity. He was also, if possible, even more enervated than his northern brother.

These difficulties increased during Bulan Puasa (Ramadan), the month of fasting, which the Malays, being Mohammedans, observed. Whether the coolies observed the fast or not, it was used as a heaven-sent excuse for every form of malingering and idleness.

It can easily be seen how vital an assured and efficient labour force was to the accuracy and speed of the survey. The topographer found that as soon as he had trained his party to their various jobs and taught them to cut *rentis* straight, they disappeared or went sick, and he had to commence all over again. This was worse in the early days, with an imperfect knowledge of the language.

On the other hand it was found that for trig. work, where the scene was continually changing and the work was only severe for intermittent short periods, the Malay was excellent, and showed considerable natural skill both in clearing jungle and in climbing trees to affix signals. He even at times appeared to take an interest in his work!

4. *Dyáks.*

In these circumstances it was decided to try some other nationality as coolies for the topographers, and at this juncture, by a stroke of luck, a party of 15 Dyaks from Sarawak turned up in Johore-Bahru, looking for any work which would enable them to avoid falling into their besetting sin of stealing Government gutta-percha from the forest reserves. This party, clad in a minimum and tattooed from head to foot, speaking a strange language and exuding a noisy geniality over all with whom they came in contact, were signed on, not without some misgivings, and ultimately became the nucleus of our labour force.

The Dyak as recruited by the Colonial Survey Section in Sarawak is an excellent survey coolie if the following points are borne in mind:—

First, he is entirely unaccustomed to the ways of the white man. He has probably only encountered one or two in his life, which gives a mutual unexpectedness to all dealings with him.

Secondly, he is in no sense a coolie; an independent colleague is more nearly his attitude, and this without any lack of respect or willingness on his part.

Thirdly, he is more easily ruled by a combination of humour and firmness than any other method.

He makes an excellent worker and is a born naturalist and jungle man, and was a source of continual satisfaction and amusement to the writer for 2½ years. The descendant of head-hunters, he has a tendency to relapse upon occasion, but only once in the history of the Section was a Dyak actually discovered with a newly-garnered human head, which was in use as a pillow! The head had not belonged however to a member of the Corps.

He is the Aberdonian of the East. His living expenses in the jungle are nil, for his diet, though catholic, is inexpensive. It does not need a grocer's store to supply him with snakes, monkeys, roots, fruit, soft bark (or in some cases fowls from the unsuspecting

villagers.) All his pay is banked with his master, but at the end of his year's work he returns to his country a Capitalist.

When he does go sick it is next to impossible to get him to go to a hospital, for, as he rightly says, so many people go in alive and come out dead, and in his own case, as he invariably delays his entrance till the last possible moment, this is unfortunately true. Finally, he seldom steals and never lies; he is not yet sufficiently civilised.

H. Technical Details.

1. *Trig. Work.*

(a) The country being covered with jungle, trig. work was both difficult and expensive. Primary or secondary points which required all-round vision necessitated a very large amount of clearing, a slow and costly process. Hence it was necessary to curtail the number of points that required all-round vision and make the maximum use of stations fixed by resection or intersection which required the cutting of lanes or rays only through the jungle, or in fortunate cases no cutting at all.

In the more developed part of the country where Revenue boundary work existed in profusion, it was only necessary to fix one or two new trig. points as a check to the existing work, and to give heights to as many of the Revenue points as was necessary.

The existing triangulation was therefore broken down by means of a secondary system, the sides of the new triangulation averaging some 6 to 8 miles. Within this system further points were fixed by trig. re-section and by the intersection of prominent points, trees or flags hoisted above the tree tops in rubber estates. In this country large trees grow to a height of 200 ft., the lowest branches being 100 ft. or more from the ground. It will thus be realised that the task of placing survey marks on the tree tops was no easy one. The top of the tree, however, was the only point which could be seen from any distance.

The secondary system, being in the nature of a chain, had to be undertaken as one complete job, but once it was completed, the further breaking down was undertaken piecemeal, and it was generally arranged that the minor control in any area was completed just prior to its use by the topographers, a reconnaissance for it being carried out more or less fully during the reconnaissance for the secondary work. The trig. work therefore fell into two distinct operations.

As has already been explained, work was started at the south end of the south-east peninsula of Johore, where one secondary point (Pelali) and two primary points (Pengerang and Belungkor) existed. The first step was to produce sufficient control for the area south of 1° 26′ 30″ at which the topographers were to start.

This was obtained by running a secondary polygon round Pelali,

using the side and azimuth (Pengerang-Pelali) as the basis. Within this polygon, minor control was immediately fixed to fulfil the requirements of the topographer. This work was completed by the middle of December.

The next step was to carry the secondary work up the peninsula and tie on to two primary points at its northern end within the area to be mapped by the F.M.S. Survey personnel. This work took the form of a chain of simple triangles running up the peninsula. Nothing more elaborate was attempted as the cost was prohibitive, and neither time nor money was available. This chain was cleared, beaconed, observed and computed by the end of March, 1924. The side and azimuth at the north was used and the chain computed from north to south, the error on Pengerang being negligible. This chain was afterwards extended westwards to cover the whole area which it was proposed to survey on the larger scale. This work was carried out in 1925, and the whole of the secondary work was then sent to the F.M.S. Survey Office at Kuala Lumpur, who undertook the adjustment and final computation.

The alterations due to this adjustment were so small (never exceeding 1ft. in either co-ordinate) that the topographers were not affected.

(b) As may be imagined in a country so densely covered with vegetation, it was not easy to carry out a reconnaissance and decide on the arrangement of the triangulation, and for this reason it would be well to explain the methods adopted.

A plane table was gridded at a scale of ½in. to 1 mile and the existing primary points plotted upon it. The original two points in the south having been re-cleared were visited and all the possible hills cut in and thus located within a small margin of error. The most suitable for the carrying forward of the triangulation were selected, visited and cleared, and if they proved satisfactory the same method was again employed.

When a hill was isolated there was not much difficulty in finding it, but when one was trying to locate the highest peak in a mass of jungle-clad hills, it became a more complicated question. The method usually employed was to run on a straight compass line from some known point, cutting a dead-straight path on what the Navy would call a dead reckoning, until the hill was reached. The only method of ascertaining whether the hill when reached was the correct one was by the process, somewhat dangerous to the amateur, of climbing small trees.

Beaconing was, of course, an easy matter. Small trees cut down during the clearing were used as legs, and with the help of *ratan*, a local creeper, rope, and a few 6in. nails, a quadrupod was quickly erected, the legs crossed at the crutch to give two inverted cones. The lower cone was made of small sticks nailed close together,

and then covered with white linen if the beacon was not on the sky line; the upper cone or basket was filled with bracken, fern, etc., which was secured by struts across the top and sides.

This beacon proved very satisfactory, and if the legs were carefully selected from hard wood they withstood the ravages of wind and weather for some two to three years—in fact, until it was necessary to re-clear the hill.

The F.M.S. Survey Department used a metal quadrupod beacon with a diamond-shaped top for their primary points.

(c) The main points were marked by a 6ft. galvanised iron pipe driven in the ground, with approximately 6in. showing above, and embedded in a block of concrete; the minor points were marked by a 3ft. stone pillar (granite or cement) let into the ground to a depth of 2ft. 6ins.

(d) Until the secondary trig. work was completed, two trig. parties were organised, each consisting of one officer and 20-25 coolies. Camp was pitched near a hill to be trigged, the majority of the coolies were employed on cutting, while the officer with a few coolies continued the reconnaissance for the secondary and minor trig. in the neighbouring country. In the course of the trig. work it was found that as much time was spent in locating and reaching the hill as in the actual clearing, beaconing and observing. In the dense undergrowth a day's trek with camp and gear was not much more than 7 or 8 miles. No progress could be made without continual use of a heavy knife for clearing undergrowth and for freeing oneself from the embrace of every known type of creeper.

(e) The secondary work was computed by means of Clark's or Puissant's formulæ, figures being adjusted by field methods only. The projection adopted in Malaya being Cassini's, each state having its own origin, the geographicals so obtained were converted into rectangular spheroidal co-ordinates.

All tertiary or minor work was computed on rectangular co-ordinates, treating the surface of the earth as flat. The plane tables were plotted on co-ordinates, the board being gridded and each topographer being issued with the co-ordinates of his sheet edges and of all trig. points which he required to control his work.

(2) Topography.

Introduction.

It is not to be expected that a topographer trained in England should find himself at home in the dense jungle or on the open veldt—English conditions of indifferent visibility and hedgerow timber are perhaps intermediate between these extremes—but whereas the latter affords ideal scope for the plane table, the former emphatically does not. Having walked into the Malayan jungle, and finding that his vision was limited to a circle of five yards

diameter, the topographer soon realised that the usual plane table methods were more or less useless, and that he had to learn afresh.

The only methods possible were naturally some sort of traverse, theodolite, compass, rope and sound or time, but it was also as obvious that some definite method should be laid down if an equal standard of accuracy was to be maintained by each topographer. The methods employed by the F.M.S. Survey Department were adopted at the outset, and worked well until our own experience dictated alternatives, for it must be remembered that the F.M.S. rules are framed to compete with the idiosyncrasies of the native topographer.

Original Methods.

Each field party consisted of one N.C.O. and 10-15 coolies, and at the start each party was given one quarter of a 15-minute sheet, approximately an area of $18\frac{1}{2}$ miles square. The N.C.O. was issued with a list of trig. points within or close to this area, a list of any Revenue boundary stones available, and a rough sketch map made by the trig. reconnaissance officer, showing the general lie of the country and the direction of streams, etc. in it.

The N.C.O. was instructed to break his area into blocks by means of compass and chain traverses between trig. points, these traverses to be plotted on double scale on squared paper, adjusted and transferred to the field board. Each block had to be surveyed for detail after it had been controlled. The detail was obtained by compass and chain traverses within the controlled area, following streams and other main features as each topographer thought most suitable for his particular area; heights were carried through by Indian clinometer.

It was found, however, that this method was not entirely suitable. Because no traverse could be run without the undergrowth being previously cleared, the topographer was always being held up by his cutting party. Compass traverses which twist and turn were not easy to plot and gave numerous loopholes for mistakes. Important pieces of ground were apt to be missed out, and it was difficult to avoid overlapping and doing work twice. No two topographers would ever cover the ground in the same way, and therefore the standard of accuracy in two adjoining sheets would tend to vary considerably. It was therefore decided to adopt the following rules:—

1. All traverses were to be straight as far as possible.

2. The topographer was to divide his coolies into two parties one of which was employed on cutting the necessary path or *rentis* some days ahead of the surveying, so that the second or surveying party should never be held up.

3. Blocks should be arranged on some definite system regardless of the features of the country, except such small hilly areas as were to be found.

The following method was finally evolved. Each topographer was given a sheet ($\frac{1}{8}$th of a 15-minute square) $4\frac{1}{4} \times 2\frac{1}{8}$ miles approximately, for it was found that the larger sheets as originally given took too long to complete, and the Section became too scattered for efficient administration.

The topographer was supplied with a list of co-ordinates of trig. points and of his sheet corners, a tracing of the Revenue work in his sheet, showing all boundary stones and the traverse lines by which they were fixed, co-ordinates of the Revenue stones, air photographs covering the area, and an air compilation, if one existed. The topographer gridded his board in 1,000 yard grids and plotted his sheet corners, trig. points, etc. The working method employed was as follows :—

The sheet edges were traversed in straight traverses called main lines, the area was then cut into blocks by auxiliary lines, each block being approximately $2\frac{1}{8}$th miles (the breadth of the sheet) by 1,000 to 1,200 yards. These blocks were then surveyed by detail lines run parallel to each other, and at right angles to the auxiliary lines. The distance apart of the detail lines depended on the country, the steeper and more complicated the topography the closer the lines. It was generally found convenient to place them between 300 and 400 feet apart. It will thus be seen that approximately 17 miles of *rentis* had to be cut to survey one square mile of jungle country.

The topographer was responsible for arranging the cutting of the main, auxiliary, and detail lines prior to the survey. For instance, in a sheet partly rubber and partly jungle he could survey the rubber first with some of his coolies while the remainder were cutting in the jungle.

The division of the sheet into blocks was also arranged so that the detail lines ran at right angles to the general run of the streams.

All lines were traversed with a chain and compass, the heights were carried forward by the Indian clinometer. The main lines were surveyed first and plotted on an auxiliary board to double the scale, reduced, adjusted, and transferred to the full boards.

Pickets with the ground height marked on them were left at the junction of these main lines with the auxiliary and detail lines.

The auxiliary lines were next surveyed between the pickets left on the main lines and transferred to the field board in the same way as the main lines.

The ends of the previously cut detail lines having been picked up on the auxiliary lines, the detail lines were surveyed direct on to

the plane table, for no error in length in a straight traverse 1,000 to 1,200 yards long was plottable on the 1/20,000 scale.

Should there be any doubt in the mind of the topographer as to features contained in the space between detail lines, he could always run a short compass line out to one side to clear up the doubtful point.

By this means it was found possible for the topographer to survey about four detail lines a day, or, once his control was surveyed, to complete one-fifth of a square mile a day, or allowing for control, four square miles a month in average country.

In order to simplify the work of the topographers and to obviate the necessity for large numbers of coolies with each field party, a pool of coolies was later formed and put under the control of the Officer-in-charge of the minor control, which you will remember was always carried out a month or two before the topographers entered any given area. This pool was employed in cutting all lines in advance under the direction of this officer, and the topographer on arriving in the sheet was given a diagram showing the lines which were cut in advance and the position of his control.

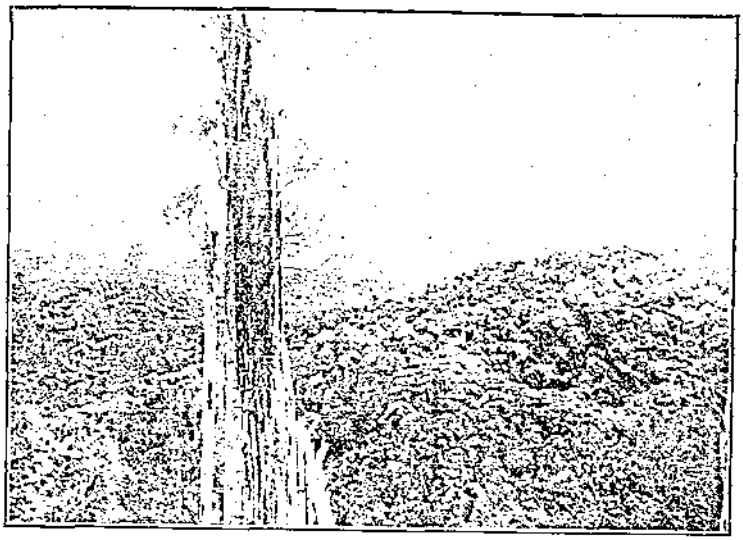
The pool system worked well as long as it was possible to supervise the work properly, but failed immediately European supervision had, for any reason, to be withdrawn.

In rubber and other cultivated country, the same method was adopted. Areas were blocked off and then surveyed with parallel detail lines, but their distance apart was varied by the topographer according to the lie of the country and the length of vision obtainable on either side. In this case of course a compass was used in surveying the detail lines, and each line was tied in to pickets left on the auxiliary traverse when an area was blocked in.

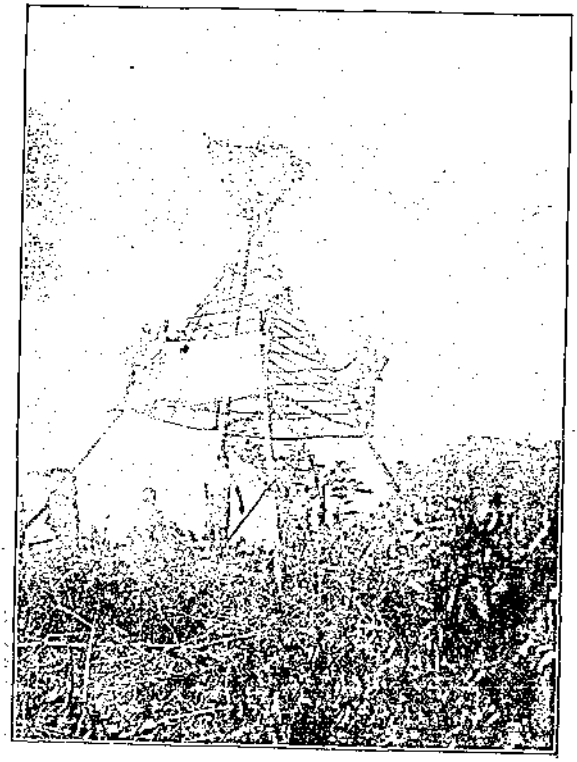
Criticism may be offered to these methods, namely, that they were too rigid, and cut out the initiative and individuality of the topographer. It should be borne in mind, however, that it is better to have a map in the whole of which the standard of accuracy is the same than one which has a varying standard, and that on a scale of 1/20,000 in a country which was being rapidly developed, one cannot afford to make errors. It was very interesting to take a map made in an area covered with jungle and compare it with the ground after it had been cleared of jungle for rubber planting. Such a comparison, in fact, made very obvious the necessity of covering the country with parallel traverses as described above.

With the help of air photographs, the survey of rubber and mangrove detail was simple. The detail work, using the methods previously described, was taken up to the back edge of the mangrove swamps (which, be it remembered, are always tidal) or to the river itself where possible. Such points were always clearly defined on the photograph. Points already fixed on the plane table were

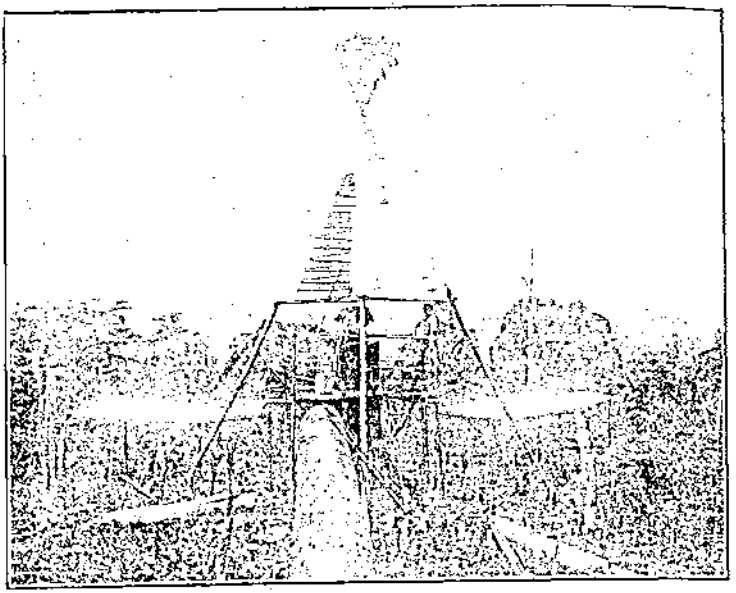
A COLONIAL SURVEY SECTION, R.E., IN MALAYA, 1923-26.



1.—The view of jungle-covered hills from a trig. point.



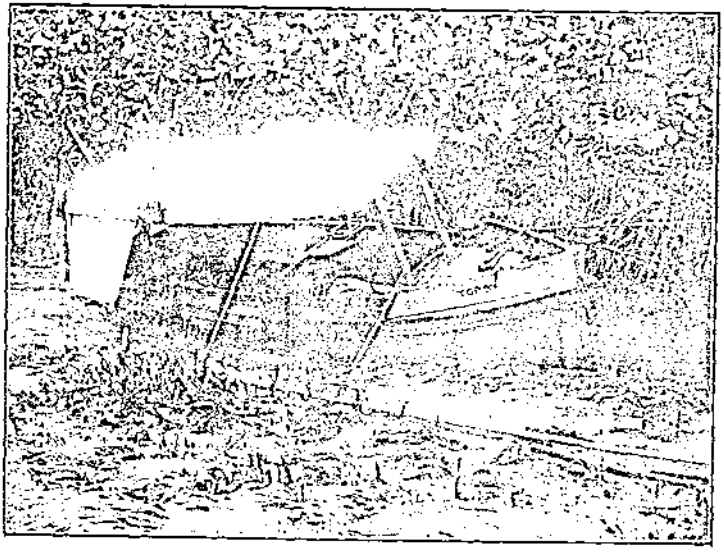
2.—A Beacon in course of construction.



3.—A Beacon showing the aeroplane photograph marks.

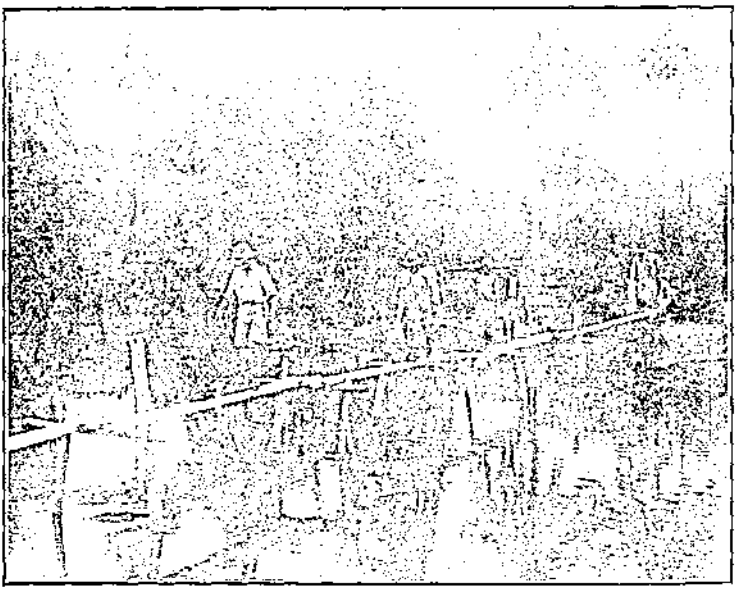
4.—Marking a tree. The undergrowth was subsequently cleared.

5.—A Trig. Station being cleared, work half completed.



6.—The Motor Launch in difficulties;

7.—Preparing to shift camp, Pulai Rubber Estate.



8.—Trig. party crossing a bridge.

recognised on the photographs, and the intervening detail was transferred from the photograph to the map by means of proportional compasses, using the centre portion of each photograph only and fixing detail by intersections from known control points. (So long as the ground is flat a straight line always remains a straight line whatever the distortion due to tilt). A very accurate result was obtained, greatly superior to any which could be expected by any other means of ground survey.

(I) CONCLUSION:

The original section was relieved in 1926, on the completion of three years in the country. During this period approximately 600 square miles of map had been produced on the 1/20,000 scale, and in addition control had been provided for the remainder of the large scale work, and for portions of the area to be mapped on the 1in. scale.

The Section still continues its labours, and at the time of writing the large scale work has been completed. It is now busily engaged in tackling the problem of how to produce a 1in. map at economic speed and cost.

Perhaps it would not be out of place to end up in a reminiscent vein. It is not everyone's luck to get away from the routine jobs of the average sapper's life to one of this description. The work had, of course, its difficulties, hardships and awkward moments, but in retrospect they fade into insignificance compared with the interest of men, country and things, the balance of open air and office, the freedom, the remoteness of red tape, and the ultimate achievement of a topographical survey.

ENGINEER TRAINING IN THE TERRITORIAL ARMY.

A Lecture delivered at Chatham on 13th October, 1927.

By Colonel E. N. Stockley, D.S.O., Chief Engineer, Western Command.

Taking the Engineer Units of the Army as a whole, the Territorial Units are "the principal force," and form no mean part of "the backbone of our military structure," as our Territorial Army has recently been styled by an eminent writer on military subjects. This great mass of skilled mechanics and artisans, officered by men of ability who are themselves in practice as engineers, architects, and in the cognate professions, look to us regular officers and their permanent staff N.C.O's for guidance as to the manner in which the time they voluntarily give up for military training may best be used, so that when the time comes for their engineering skill and trade dexterity to be used to the best advantage in the military machine, they will "be prepared."

The training of our regular Units forms the model on which the training of the Territorial Units is based, and this S.M.E. is the centre of thought for the training of all our Units, whether Regulars, S.R. or T.A., in military engineering.

The principles and system of training are laid down in the textbook *Engineer Training, Volume* 2, with which I hope you are all familiar. First, as you will agree, the book contains a great deal of pithy matter and takes a lot of reading, but it does not, of course, deal much with Engineer Training of the Territorial Army. It deals primarily with the Engineering Training of the Regular Army, on which the training of the Territorial Army is based. It lays down in general terms that, so far as time admits, the officers and other ranks of the S.R. and T.A. will carry out, by means of evening courses of instruction and by modified field works, or specialised courses with Units during the period of annual camp, a course of training for their duties in war similar to that specified for the Regular Army Units.

I need not trouble to read the book to you, but I would just like to mention one or two extracts from it that will show you the line it has taken. Now Section 5 (4), about the training of officers tells you that the C.R.E. Territorial Division will draw up a yearly programme of training for all ranks under his command. He will

keep in close touch with the Chief Engineer as regards the facilities for technical training, as well as with the General Staff of his division as regards military training. It is stated in Section 6 (1) that during the course of the year the Territorial Army Recruit will carry out a course of training similar to that of the Regular Army Recruit by means of evening instruction and week-end camps. This may be modified as necessary. As regards the annual training, it states in Section 10 (11) that it is not possible for the S.R. and T.A. Engineers, in the limited time of training at their disposal, to carry out the whole course as laid down for Regulars, but the spirit of the instructions should be observed. Their annual training in camp should be principally devoted to field works, demolition and bridging, or any practical work connected with the special branch of engineering work for which the Unit is intended in war.

My lecture will endeavour to show you how practical effect is given to these instructions.

The training of the Units must vary very greatly according to the work they are called on to do in war. They are necessarily more specialised than our Regular Army Units.

Appendix I shows you the location and the grouping of the Units of the Territorial Army and S.R. You will observe that there are five main groups of engineers.

(1). The Divisional Engineers (T.A.), consisting of 1 Field Squadron and 14 Divisional R.E., which have their counterpart in the 1 Field Squadron and the few Field Companies of the Regular Army.

(2). A.T. and E. & M. Coys. (S.R.) These have no counterpart in the Regular Army and are enlisted on a S.R. basis, so that they may be ready to mobilise with the Regular Army on the outbreak of war.

(3). Fortress Companies, which are mainly concerned with coastal defences.

(4). A.A. Searchlight Battalions and Independent Companies.

(5). Transportation Units.

To take the transportation groups first, they consist of :—

2	Railway	Plate-laying Companies.
1	,,	Bridging Company.
2	,,	Operating Companies.
1	,,	Docks Company.
2	,,	Workshops Companies.
1	,,	Stores Company.

These men are enlisted from a long waiting list of volunteers willing to serve, of men who are employed on the railways at home, officered by their own railway officers, and they will in war be carrying out practically the same work as in their civil occupations. The officers and sergeants of all these Units come up for a fortnight's

training at Longmoor in military and technical work, and to study military railway problems. The other ranks, however, of the two Railway Plate-Laying Companies and the Bridging Company only are called up for training, which consists mainly of practical work, *e.g.*, end-on plate-laying, practice with the flat-bottomed rail spiked to sleepers, such as you meet abroad but seldom at home, heavy timber bridging as used on service, etc.

The other Units do no military training at all in peace time, except the officers and senior N.C.O's, as it is felt that the work of the rank and file will be so very similar to what it is in peace that their time is more usefully spent in actual practice on the line, on railway operating, railway workshops and stores work. These men, of course, receive their bounty for giving a lien on their services.

The training of the Anti-aircraft Units is essentially specialised for their work in war, which has no direct counterpart in peace, and differs from the mobile work of the 1st A.A. Battalion R.E. All the Units of the A.A. Group are required to man the searchlights in the Air Defence of Great Britain.

I will now turn to the training of the Divisional R.E., A.T. Companies and Fortress Companies, with which the Chief Engineers of Commands are concerned.

The organisation of these Units is shown in Appendices II and III.

In the Divisional R.E. there are only three sections in each Field Company, and there is no Field Park Company. Enough horses are hired to horse one toolcart and one L.G.S. wagon per section. Pontoon wagons, when taken to camp, are either hauled by lorry, or horsed to and from the station by a second trip of the toolcart horses.

In the A.T. and E. & M. Companies only hired transport is allowed. There are no horses. Being Supplementary Reserve Units, and therefore liable for immediate service on mobilisation, their Peace Establishment is the same as their War Establishment.

The Field Squadron is at present horsed, but will shortly be mechanised. It consists of Headquarters and 3 Brigade Troops.

A Fortress Company is divided into Lights Sections and Works Sections. The equipment held by these units is meagre, and unless supplemented gives little scope for variety in training in military engineering at the annual training camps.

In the Western Command the keynote of our training in Military Engineering is to have one command training centre at Monmouth to which Units go in turn for annual camp.

At this centre we have collected stores and plant to enable the full fortnight's programme of interesting and varied military engineering work to be undertaken. The illustrations show a few examples of the work carried out this year at Monmouth and elsewhere.

The season of active outdoor work for the Territorial Army, which forms the climax of the training year, finishes in September. All the Divisional Staffs begin, after a brief interval, planning and arranging the proposals for next year's training, examining reports, etc. The land for the camp has to be hired, after it is decided where they will camp, and the R.E. Adjutant is kept busy preparing projects for water supply, camp services, etc., and getting out specifications and plans, not only for his own camp but for all those of his Division. He occupies the dual position of Executive Engineer for his Division, as well as Adjutant and Quartermaster of his own Unit.

It is, therefore, a busy and very interesting job for an enthusiastic officer, keen on military work; it gives insight into the work and organisation of all arms, and is an excellent training for staff work.

The C.O., Adjutant, and Company Commanders begin preparing the programme for winter training and the weekly drills. Their permanent staff get busy with recruit training, and, incidentally, they are also busy, not only at this time of the year, with recruiting for the Regular Army, for they too have a dual role of recruiter as well as instructor.

Arrangements have to be made for Officers' promotion classes, for the training of specialists, and for preparing N.C.O's for Chatham courses. The winter programme must especially cater for the instruction of Officers and N.C.O's, so that they in turn may be able to instruct their men when the time for collective training comes.

The past training season has brought out two noticeably weak points:—(A) The Training of Officers. (B) Organisation of Training.

With regard to this, I will give you a few notes which are the result of the thought I have given to this matter:—

(A). *Training of Officers.*

It is, to my mind, most essential that in the little time he may have—especially in the case of a Junior Officer—an officer should be well-trained, so as actually to be the instructor of his Command. One cannot expect to produce a good Section without a good Section Officer.

S.R. and Coast Defence Units are required to be fully trained before embodiment. Other Units will probably be given some time after embodiment to recruit and complete their training, but there will not then be time to train their Officers. At any rate, in all Units it is of paramount importance that the Officers should be fully trained before embodiment, because they will then get a vast number of recruits who will have to be trained.

An Officer's training is partly practical and partly theoretical. The theoretical part consists mainly of the study of text-books, lectures and exercises without troops; the practical part consists in handling his Command on a job of work.

It is universally found to be a comparatively rare sight to see a Territorial Officer actually in full executive control of his Command; his role is more usually confined to looking on whilst an N.C.O. takes charge and is the moving spirit. I suggest that this may be partly due to lack of self-confidence, which can only be overcome by practice, or it may be due to lack of detail knowledge of military work, which points to insufficient preliminary training.

However, it is plain a Regular Officer must not criticize Territorials too much. Their work and their methods are, in many ways, different from ours, and the main point is that they get the job done, and well done, too. In civil life these Officers, who are architects, civil engineers, and so on, are accustomed to design and arrange works and to control from the office. It is the practice for the foreman to take control of the men on the work, and it is rather natural that they should bring the practice of their normal life into our military work. It takes a keen man to do this work, and I think we want to encourage these excellent fellows in every way we can. We want men of the right professions who are prepared to give up their spare time and to join in the evening training, and to forego what is practically their fortnight's holiday with their wives and families to come out to camp every year.

(B). *Organisation of Training.*

The shortness of time available is the basis of the whole question of training in the T.A. It is, therefore, of the greatest importance that every minute be used to the best advantage.

Forethought and organisation are essential to avoid waste of time, which frequently arises from small and avoidable causes, such as tools and stores not being prepared beforehand.

It is of no use attempting to cover the whole ground of training in one year. Concentration upon certain subjects each year will ensure that in a period of four years' service each man will have learnt all the essentials. The selected subjects should form the basis of study during the individual training season.

A recruit's training should be confined to those subjects which are the basis of all subsequent training, *i.e.*, making him a soldier, handling of tools, knots and lashing; but these must be taught thoroughly. It is not then necessary to allot whole "drills" for repetition of them in subsequent years; fifteen minutes of refresher work at the beginning of an evening will suffice.

The average man attends few drills more than are necessary to earn his Bounty or Proficiency Pay, *i.e.*, 20-25 per annum. Satisfactory training cannot be carried out unless there is a sufficient number of men on parade, and in order to secure a reasonable attendance at all parades, it is necessary to limit the number of opportunities for attending drills. If only thirty opportunities (*i.e.*, 2 hours one night per week for 15 weeks) were given for doing

drills to earn Proficiency Pay, there would always be a reasonable attendance. The keen man can be catered for by means of an additional "voluntary" night each week. Further advantages likely to be gained from this method are :—

(*a*). It is easier to attain systematic and progressive training.

(*b*). The instruction given is of a higher standard, because Officer and N.C.O's find it easier to be always present, and have a better chance of "getting up" their subjects beforehand.

The "shift" system prevailing in Mining and some other Districts is a common source of difficulty. The working day is extended by fresh men coming on duty when the first relief has finished its day's work. But, from our point of view, this means that it is quite impossible for a man on an evening shift to attend parades at the Drill Hall. This was overcome in one Unit by cutting out all evening parades and substituting Sunday morning parades, each lasting three hours and counting as three drills. This, also, facilitated the task of Officers and N.C.O's.

A detailed and exact programme cannot be adhered to in practice during the pre-camp period. It is better, therefore, for the Company Commander to prepare a programme on broad lines, the details of which can be adjusted in accordance with circumstances each night.

Such a programme might be :—March : Preliminary Musketry. April : Use of spars, anchorages. May : Pontoon Bridging. June : Demolitions.

A logical sequence should be followed, *i.e.*, the preliminary musketry period should come immediately before firing the annual range course. Instruction in anchorages should precede the "use of spars."

Compulsory wearing of uniform at drills, once the men are accustomed to it, is popular, and has a wonderful effect in promoting smartness and *esprit de corps*. It has been achieved even in socialist districts in face of much opposition.

To sum up, in order that full value may be obtained from very limited time available : Officers must use forethought and organise the training of their Commands, so that all non-essentials are excluded, whilst essentials are thoroughly taught and in logical sequence to all, and so that not one minute is wasted. To do work at camp which could equally well be taught in the restricted scope of a drill hall is not organisation.

Finally, I would like to mention a few points which occur to me as important if we are to improve the training of T.A. engineers.

In the Divisional R.E. I cannot help thinking that the organisation is wrong; that we do want that 4th Section in the Field Company very badly. I feel the need for a cadre of the Field Park Company,

which, unfortunately, had to be reduced last year on economical grounds. Even if we cannot have that, I feel the need very greatly for a Quartermaster, or, at least, a Regimental Quartermaster-Sergeant to take charge of all the regimental equipment.

I point out to you that the Territorial Divisional Engineers are very regimental; more so, I think, than Regulars in a sense.

We have had no opportunity as yet for work with the medium and heavy pontoon equipment. At present there are only two Pontoon Parks, one at Chatham and one at Mudeford. These are quite beyond the reach of the Western, Northern and Scottish Commands. A small amount of material has recently become available in the Northern Command, and I believe there is a possibility of forming a centre at Chilwell, near Nottingham, which would be available for the Northern and Western Commands.

I think we want a much closer co-operation with the Regulars. The 1st Field Squadron (Regular) is now affiliated to the 2nd Field Squadron (T.A.) and other affiliations of the same sort might well follow. In the Western Command I have arranged for every Works Officer below the rank of C.R.E. to attend a Territorial Training Camp for a fortnight. They have all been out this year, and the innovation was found to be most successful and beneficial to all parties.

Unfortunately, I have not got enough Regular Officers to go round. There are very few regular R.E. Officers in the Western Command. It is the biggest Territorial Command that there is, and we should like to counterbalance it more or less. Other Commands who have few or no Territorials might be very glad to take what is really a very valuable opportunity of giving their Officers a fortnight's military work, and I might put out a suggestion for the attachment of Junior Officers from the S.M.E. to Territorial Companies during the time of their doing their military training.

T.A. Officers might go for their fortnight's training with a Regular Unit, so that they would see something of us and we would see something of them; but whatever arrangements are made, I would like those officers who go, or exchange, to have a definite command (an executive command) in that Unit. This I think is most essential and is laid down in *R.E. Training*, *Sec.* 1., *Para.* 6.

I would ask all who have any chance of helping in the selection of Adjutants and Permanent Staff to give us the best they have, regardless of the effect on Regular Units. The responsibility is great and the effect of a limp man far-reaching.

ENGINEER TRAINING IN THE T.A.

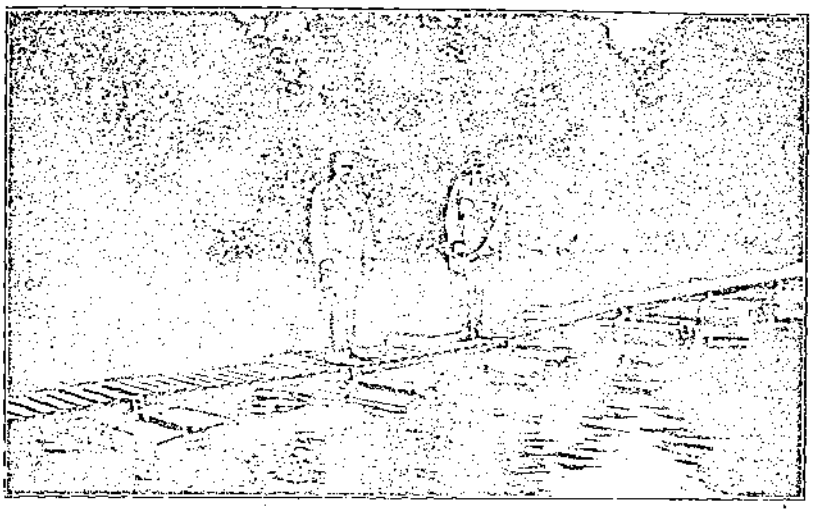


Fig. 1.—Kapok Bridge.

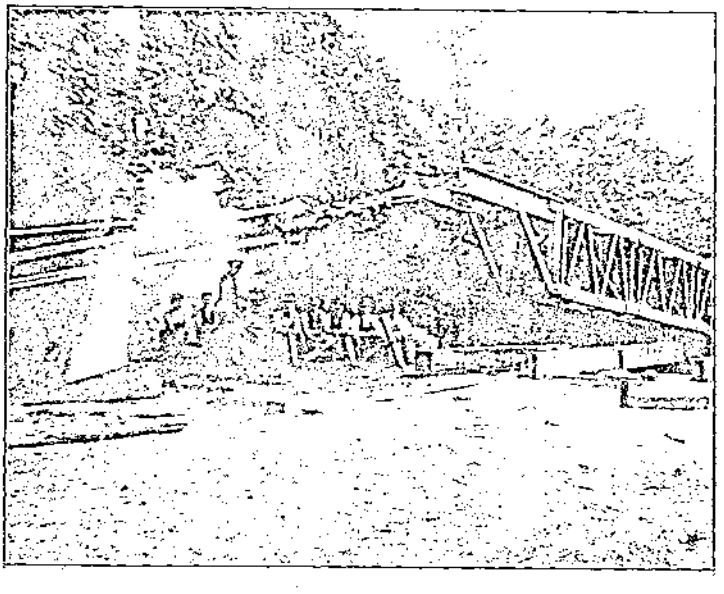


Fig. 2.—80-ft. span Martel Bridge.

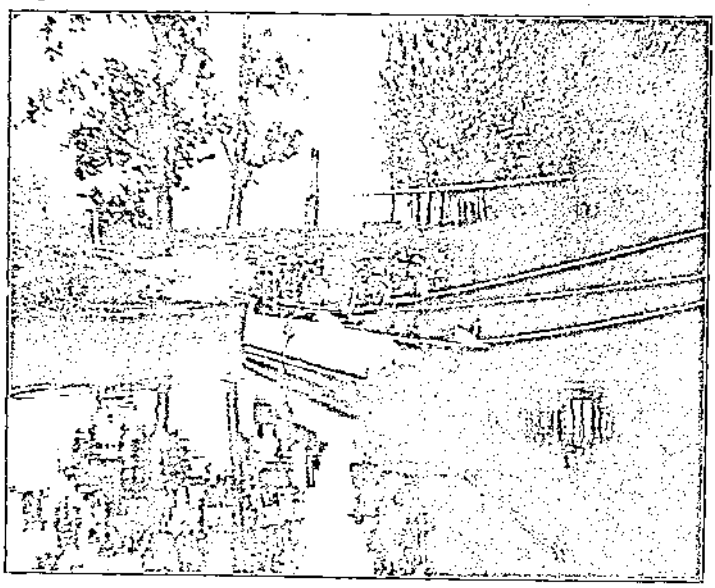


Fig. 3.—Pontooning.

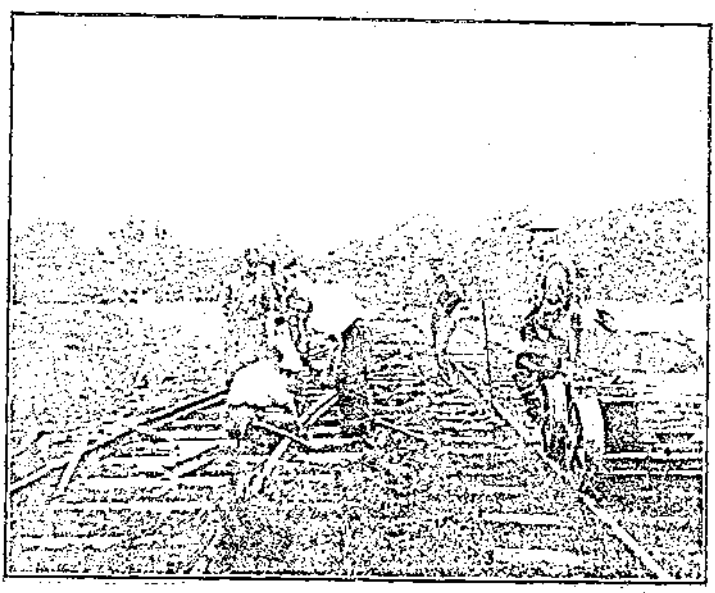


Fig. 4.—Railway Work.

APPENDIX I.

LOCATION AND LIST OF R.E. UNITS, S.R. AND T.A.

DIVISIONAL R.E., T.A.

2nd (Cheshire) Field Squadron 2nd Cavalry Division	Birkenhead.
42nd East Lancs.	Manchester.
43rd Wessex	Bath.
44th Home Counties	Brighton.
46th North Midland	Birmingham.
47th 2nd London	Chelsea.
48th South Midland	Bristol.
49th West Riding.	Sheffield.
50th Northumbrian	Newcastle-on-Tyne.
51st Highland	Aberdeen.
52nd Lowland	Glasgow.
53rd Welsh	Cardiff.
54th East Anglian	Bedford.
55th West Lancs.	Liverpool.
56th 1st London	Bethnal Green.

ARMY TROOPS S.R.

100th (Royal Monmouthshire) A.T. Company	Monmouth.
101st do.	Monmouth.
102nd (London) A.T. Company	Bethnal Green.
103rd (Glasgow) A.T. Company	Glasgow.
104th (East Lancs.) A.T. Company	Manchester.
105th (West Lancs.) E. & M. Company	Liverpool.
106th (West Riding) A.T. Company	Sheffield.
107th (North Riding) A.T. Company	Middlesbrough.
108th (Essex) E. & M. Company	Chelmsford.

FORTRESS ENGINEERS.

City of Aberdeen	Aberdeen.
Carmarthenshire	Llanelly.
Cinque Ports	Dover.
Cornwall	Falmouth.
Devonshire	Plymouth.
Dorsetshire	Weymouth.
City of Dundee	Dundee.
City of Edinburgh	Edinburgh.
Essex	Chelmsford.
Glamorgan	Barry.
Hampshire	Portsmouth.
Lancashire	Liverpool.
Renfrewshire	Greenock.
East Riding	Hull.
North Riding	Middlesbrough.
Tyne Electrical	North Shields.

ANTI-AIRCRAFT T.A.

26th (London) A.A. Bn.	Chelsea.
27th (London) A.A. Bn.	London.
307th (Tyne) A.A. Coy.	North Shields.

Essex Group.

309th A.A. Company	Harlow.
310th do.	Epping.
311th do.	Brentwood.
312th do.	Hornchurch.

Kent and Middlesex Group.

313th A.A. Company	Gillingham.
314th do.	Southborough.
317th do.	Southall.

Surrey Group.

315th A.A. Company	Croydon.
316th do.	Kingston.
318th do.	Guildford.

TRANSPORTATION UNITS, S.R.

No. 1 (L. & N.E.) Railway Plate-laying Company	Stratford.
No. 2 (G.W.) do.	Paddington.
No. 1 Railway Bridging Company	Paddington.
No. 1 (L. & N.E.) Railway Operating Company	York.
No. 2 (G.W.) do.	Newport (Mon.)
No. 3 (L. & N.E.) do.	Doncaster.
No. 4 (G.W.) do.	Paddington.
No. 1 (L.M.S.) Railway Workshop Company (Advanced)	Derby.
No. 2 (L.M.S.) do. (Base)	Crewe.
No. 1 (Southern) Railway Stores Company	Southampton.
No. 1 (L. & N.E.) Docks Company	Newcastle.

APPENDIX II.

ORGANIZATION OF DIVISIONAL R.E., T.A. (PEACE ESTABLISHMENT).

Headquarters.

Personnel.	*Horses.*	*Vehicles.*
1 C.R.E. (Lt.-Col.)	1	6 Pontoon Wagons (No Horses
1 Adjutant (P.S.)	1	3 Trestle Wagons or Drivers
1 R.S.M. (P.S.)		1 Heavy Lorry, hired)
1 Orderly Rm. Sergt.		1 Bicycle.
3 Sappers.		

"A" Field Company.

Headquarters.

Personnel.	*Horses.*	*Vehicles.*
1 Major	1	
1 Captain	1	
1 C.S.M.		
1 C.Q.M.S.		
1 Sergt. (Mtd.)	1	
3 Cpls. (1 Mtd.)	1	
16 Sappers.		2 Bicycles.
2 Drivers (Spare).		

No. 1 Section.

Personnel.	*Vehicles.*	*Horses.*
1 Subaltern.	1 Double Tool Cart.	1
2 Sergts.		
8 Corpls.	1 L.G.S. Wagon.	4
37 Sappers.		2
3 Drivers.	3 Bicycles.	

No. 2 Section. (As for No. 1 Section).

No. 3 Section.

"B" Field Company. (As for "A" Field Company).

"C" Field Company.

Summary.	Section.	Field Co.	Divnl. R.E. Territorial	Divnl. R.E. Regular. (Permt. Staff).
Officers	1	5	16	1
W.O's and N.C.O's	10	36	109	4
Sappers	37	127	384	—
Drivers	3	11	33	—
Total	51	179	542	5
Horses	7	25	76	1
Bicycles	3	11	34	—
Double Tool Carts	1	3	9	—
L.G.S. Wagons	1	3	9	—
Pontoon & Trestle Wagons ..	—	—	9	—
Lorries	—	—	1	—

APPENDIX III.

2nd (CHESHIRE) FIELD SQUADRON, T.A.

Headquarters.
1 Major.
11 Other Ranks.

Total .. Officers 9
Other Ranks 154
Horses 143

Headquarter Troop.
1 Captain.
1 Subaltern.
26 Other Ranks.

"A" Brigade Troop.
2 Subalterns.
39 Other Ranks.

"B" Brigade Troop.
(As for "A" Brigade Troop).

"C" Brigade Troop.

ARMY TROOPS COMPANY S.R.

Headquarters.
1 Major.
1 Captain.
34 Other Ranks.

Total .. Officers
Other Ranks 242

"A" Section.
1 Subaltern.
52 Other Ranks.

"B" Section.

"C" Section.
(As for "A" Section).

"D" Section.

ELECTRICAL AND MECHANICAL COMPANY.

Headquarters.
1 Major.
1 Captain.
1 Subaltern.
111 Other Ranks.

Total .. Officers 7
Other Ranks 333

"A" Section.
1 Subaltern.
47 Other Ranks.

"B" Section.

"C" Section.
(As for "A" Section).

Boring Section.
1 Captain.
81 Other Ranks.

BRIDGING.

The Problem of the "Mobile Troops."

By Capt. H. A. Baker, M.C., R.E.

"The proper co-operation of all arms wins battles and enables the infantry to confirm the victory." (*F.S.R. II, Sec.* 13 (*i*).)

Mechanization of all arms appears now to be merely a question of time, and with the formation this year of a mechanized brigade, it is imperative that we should study the requirements of such a force and see whether we are keeping pace with developments.

F.S.R.II, para. 44, discusses the duties of "the mobile troops" which have been substituted therein for "the protective screen." Their duties may be to seize and hold positions, or to deny them to the enemy until the main column arrives and/or to obtain information. We do not know much yet about the employment of such forces, but what is certain is that the whole essence of success lies in maintaining mobility.

We have had lectures recently at Chatham which have given us valuable food for thought, and suggestions have been made as to the possible development of fortification to deal with these new weapons. We have not, however, heard much about the duties of the Royal Engineers in the advance.

From the study of defence it seems probable that rivers will play an even more important part than they have done in the past in holding up an advance.

Great progress has been made recently in all-round cross-country mobility, and beyond certain impossible localities, such as swamps and forests, there is no natural obstacle to impede movement except a river.

Accepting the probability that, in carrying out their task, the mobile troops will be confronted with a river the bridges over which have been demolished or, possibly, a dry obstacle such as a canal-working in N. France, can we, with our present equipment, ensure the passage of this force without delay?

The passage of a dry obstacle should present no difficulty to cross-country vehicles, as a gap of this nature can almost certainly be circumvented.

The problem of the passage of a river falls under two heads :—

(1) In the face of serious opposition.

(2) In the face of light opposition.

It is a generally accepted fact that to establish a bridge it is necessary to capture the observation points on the other side which command the site.

In the face of serious opposition this entails a deliberately staged attack, involving strong Artillery support, use of assault bridges, etc. If the mobile troops are faced by such a situation they must either wait for the arrival of the main force, or use their mobility in an attempt to cross the obstacle round a flank.

Col. Fuller, in his recent lecture, stressed the importance to mobile forces of the crossing places, and suggested that these would become the centres of large fortified areas containing anti-tank defences.

Hence, to overcome this the mobile troops of the future must be independent of the fixed crossing places if they are to maintain mobility.

They may thus come up against an obstacle held only lightly by M.G's. and light mobile weapons which could be easily crushed by tanks if they can get across before serious reinforcements can be brought up. If tanks cannot be got across without exposure of personnel, even light opposition will entail a staged attack with consequent loss of time.

It is essential, then, that we should be able to pass tanks and armoured cars across a river without delay and in the face of M.G. fire.

To do this we have at present only the pontoon equipment and some experimental devices such as floating mats and crib piers. The drawback to all these is that their erection involves the exposure of personnel, and hence loss of time in preliminary operations.

In the circumstances under consideration it is only necessary to pass a few tanks across in order to establish a bridgehead quickly.

Can we therefore devise a method of passing tanks and armoured cars across a river under M.G. fire without exposure of personnel ?

What follows contains, in the writer's opinion, the basis of a possible solution which might be developed and tried by experiment.

The first essential is R.E. reconnaissance.

It will be necessary to find out whether bridges are demolished, and if so, the degree of opposition to be expected. If the obstacle directly ahead is strongly held, and it is decided to attempt to outflank it, reconnaissance for a suitable crossing place is required. Much of this may be possible from the air, but it will, in every case, be necessary to carry out closer reconnaissance to choose the actual site from the technical point of view. To do this it is considered that the R.E. accompanying the mobile troops will need a protected

cross-country vehicle, such as an armoured car, so that they can push right ahead with the foremost units.

At the end of the Great War an Inglis bridge was designed that could be built up behind cover, pushed up on idle tracks by a tank, and launched without a man exposing himself. The tanks could then cross the bridge. As the river may be too wide to span by a complete bridge of this nature, a raft on similar principles would probably offer the best solution.

A raft could be designed to travel in sections on, say, half-track vehicles or on idle tracks. It would be too wide to travel by road in one section, but it would be possible to divide it into portions, say roadway and floats, for this purpose. These could be quickly assembled when required. As it would probably only be required to carry Vickers tanks and armoured cars, it would not be a very heavy structure.

What is visualised is a raft of three special pontoons connected by stiffening girders, with special idle tracks under the pontoons for launching purposes.

Suppose this to be possible, how will the raft be launched? The R.E. reconnaissance will have discovered a place with suitably shelving banks which can be found on any river. The raft on its idle tracks could be assembled under cover, pushed by a tank across country and launched in a manner similar to the Inglis bridge, without a man exposing himself.

Now comes the real difficulty. If the opposite banks are held, it will be difficult to get anyone across to work the tow ropes for the raft.

It might be possible to make the raft self-propelling by installing small motors, but this would greatly complicate matters and the raft would be difficult to handle.

It would be essential to have a floating tank worked by R.E. with a winding drum to work the raft.

Although it is not at present possible to make fighting tanks float without sacrificing efficiency, owing to the weight of ammunition and petrol that has to be carried, there is no difficulty about making a tank float for a special purpose of this nature.

During the operation this tank will be very exposed, and this will be the time when the utmost Artillery support will be required.

Once the ferry is established, tanks could pass over quickly and the opposition on the other side be overcome. The pontoon equipment is, meanwhile, being brought up, and little time will be lost in providing a bridge for the main force.

It might be feasible to design the equipment so that a series of rafts could be linked up later to form a bridge, but it would probably be better to keep such specialised equipment down to a minimum,

and, once a pontoon bridge is established, withdraw the rafts by pulling them out on the other side.

To summarise, we require :—

1. A protected mobile machine for R.E. reconnaissance.

2. A floating R.E. tank, proof against M.G. fire and with winding equipment. This would, incidentally, be extremely useful for other purposes, such as launching heavy girders, and, if fitted with a light jib arm, would greatly speed up the work on building the Box Girder bridge.

3. A raft to carry a Vickers tank or whatever light tank is to accompany the mobile troops, capable of being assembled on land, towed or pushed to site and launched down a river bank, without a man exposing himself.

This does not seem an insuperable problem, and such an equipment would greatly add to the all-round mobility of mobile troops.

It seems very likely that, if we cannot devise some method of rapidly passing tanks across a river under fire, the mobile troops will be held up by the first river they come to in the hostile country until the main force comes up, thus losing the benefit of their essential characteristic, mobility.

The task, therefore, falls to us of overcoming this difficulty, and this can only be achieved by thought and experiment until some solution is found.

The solution presents many difficulties, only a few of which have been touched on above, but it is hoped that this article will lead to thought and suggestions which may go some way towards solving the problem.

MECHANISATION—A SCHEME FOR THE CONVERSION OF FIRST LINE TRANSPORT.

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

The utilization of civilian resources, both in men and material, to supplement permanent forces, is a method of effecting economy, if not efficiency, in defence which has already had much consideration, both in this country and in the Dominions.

In one direction, in the provision of 1st line transport to the Regular Army, however, there would still seem to be an opening for the further application of this system, whereby not only savings, but increased mobility, may result.

Re-Organization of the 1st Line Transport.

Recent trials at Aldershot have shown that, provided reasonable bridging equipment is carried, certain types of light lorry are able to reach practically every point on a field of battle which limbers and horse transport can, while they have obvious tactical advantage over horse transport in matters of speed, range, vulnerability, and carrying power. This being so, at first sight an elimination at home and abroad of horse transport from all arms (not excepting field artillery, now that it has been shown that a field gun can also be efficiently drawn by a light lorry) seems indicated from the point of view of military efficiency. The question, however, requires detailed investigation.

The following re-organization, *but only for the Army at home*, is suggested as a basis of discussion :—

All horsed 1st line transport will be gradually done away with. For every unit there will be formed a Reserve Mechanical Transport Section. The majority of the personnel for these sections will be drawn from civil life (a small regular cadre being maintained). All vehicles will come from civil resources. These latter will be registered, and their services ensured by a system of annual retaining fee. They will be required to be put at the disposal of the War Office for a short annual training period and to be available for purchase in war. To ensure a sufficient supply of vehicles of the right type, the existing practice of subsidizing certain varieties of light lorry will be extended. It will be necessary for the personnel required to be enlisted in a form of Reserve, and to carry out a short annual training at a time when their units are carrying out field training.

The possible objections to the above scheme are :—

(i) It is questionable whether there are sufficient drivers willing to come forward, and whether there are sufficient suitable vehicles in the country.

(ii) When the personnel come up for training, the vehicles may not be available.

(iii) Units, except for a fortnight in the year, will be without transport, and there may be difficulties over training.

(iv) There may be a delay in the mobilization of the unit, affecting the efficiency of the Army.

As regards, firstly, the sufficiency of drivers, it is certain that, even to-day, there are vastly more drivers of cars and light lorries actively employed on driving in civil life than would be required for the scheme proposed, and every day the numbers increase.* This problem is thus entirely one of obtaining the undertaking to serve from the men concerned. The liabilities of such men would certainly be serious. They would be required at any time to leave civil life at a moment's notice and to mobilize with their unit. But the difficulty is likely to resolve itself largely into a question of making enrolment sufficiently attractive. The existing Supplementary Reserve has been organized to meet very similar needs with regard to skilled personnel required by the Army on mobilization. On joining that Reserve, men receive annual bounties of between £8 and £20, according to their qualifications, and serve fifteen days each year in camp. They are required to serve in any unit in any part of the world on the issue of a Proclamation calling up any part of the Army Reserve. The numbers coming forward, up to the small limits so far required, have been satisfactory. It is therefore not unreasonable to assume that, provided the bounty is large enough, the men will be available for the scheme proposed, in which the numbers (perhaps 3,500) are not large. A bounty, for instance, of £25 per annum is a handsome attraction to most working men, while it is small compared to the annual cost of one regular soldier.

Passing next to the sufficiency of suitable vehicles, if it is insisted upon that all units be equipped with the same type, it is evident that there are not enough vehicles on the streets for the purpose required. But, provided it is accepted, at least at first, that types such as the six-wheel light lorry are only essential for certain portions (such as the machine gun sections) of the transport of certain front line units, and that other more common types will do for the remainder for the time being, it is certain that even now there is sufficient light mechanical transport in use in civil life to equip most of the Army†. An extension of the subsidy system will gradually bring about an increase of the types which the Army prefer.

* In 1926 there were over 500,000 according to official records.

† The number of Commercial Goods vehicles in the U.K. in November, 1926, was over 250,000.

The difficulty of obtaining the services of the men and the vehicles annually at the same time is one which is met with to a certain extent even now in obtaining the use of horses in the Territorial Army at the same time as men obtain leave from their employers for their annual camp. The ideal is for the driver to come up for his annual training with the vehicle he normally drives, and no doubt, in many cases, this could be arranged. The main condition for payment of the annual retaining fee to firms for their vehicles might be, further, that the vehicle was to be placed at the disposal of the Army for a period between dates to be decided by the military authorities six months in advance. On these lines, provided that the retaining fee is not too small, it is probable that the synchronization of the services of sufficient vehicles with those of the men could be effected.

As regards the position of units throughout the year, when the civilian transport is not mobilized, this difficulty might be met by maintaining in each station a pool of regular R.A.S.C. mechanical transport from which the daily wants of the garrison could be found. This work might very largely be done by units maintained for train and L. of C. duties on mobilization, which already exist.* Some increase would be necessary to the regular mechanical transport maintained in peace, particularly as regards the type required to draw and feed field artillery, but this is a step which is all to the good in view of war requirements. For training up to the Divisional Training Period, units would have to be supplied from their station pool or by borrowing from neighbouring station pools. By the suitable allocation of dates to the various brigades and battalions, this should not prove impossible. Divisional training would of course coincide with the camp period for which the civilian mechanical transport was mobilized annually, during which ample transport would be available.

Lastly, with reference to the possibly adverse influence of the scheme upon the mobilization period of the Army, even for a short sea voyage, the Expeditionary Force requires ten to fourteen days to get ready. For a long sea voyage, it is a matter of some weeks before shipping can be fitted to take even the first contingent. In either case, there would seem to be ample time to mobilize the 1st line transport. The incorporation of mechanical transport on the outbreak of war is an easier and quicker process than that of animals. Further, much of the delay in preparing shipping to take the Expeditionary Force is due to the necessity for special fitting to take animals, which might be reduced by the elimination of horse transport.

It is apparent, therefore, that the objections to the proposed

* There are 20 M.T. Companies at home on various establishments at 15 different stations. (See *Monthly Army List.*)

conversion of the 1st line transport are not such that they cannot be faced.

The Financial Aspects.

The following table gives some idea of the numbers involved in the Regular Army at home under the proposed reorganization :—

TABLE SHOWING TOTALS OF MEN, ANIMALS AND VEHICLES IN THE 1ST LINE TRANSPORT AT HOME.

Nature of Unit.	Establishment.	Per Unit. H.T. personnel.	Per Unit. H.T.* Vehicles.	Per Unit. H.T. Animals	No. of Units at Home	Totals in all Units. H.T. Personnel.	Totals in all Units. H.T. Vehicles.	Totals in all Units. H.T. Animals
Infantry Battalion	War	47	26	81	73†	3431	1898	5913
	Peace	7	8	9		511	584	657
Field Artillery Brigade	War	233	60	406	17	3961	1020	6902
	Peace	140	40	261		2380	680	4437
Field Company R.E.	War	32	21	55	12	384	252	660
	Peace	16	13	26		192	156	312
Cavalry Regiment	War	55	22	157	13	715	286	2041
	Peace	9	13	37		117	169	481
GRAND TOTALS :—War						8491	3456	15516
Peace						3200	1589	5887

* Exclusive of bicycles.
† Includes 10 Guards Battalions.
Note.—The above figures take no account of Divisional, Corps and Army Units, such as R.E., Signals, R.A.S.C., etc., nor Pack Artillery.

The financial aspects of this scheme are as follows :—

ESTIMATE OF PROBABLE SAVINGS AND EXPENDITURE INVOLVED IN A REPLACEMENT OF 1ST LINE TRANSPORT AT HOME BY CIVILIAN M.T.

(*a*) SAVINGS.

(i) *Annually.*

Maintenance costs of present H.T. :	
3,200 men @ £120 .. .. .. =	£384,000
5,887 animals @ £40* .. .. .. =	235,480
Reserves of men required on mobilization :	
5,291 men @ £25** .. .. .. =	132,275
Reserves of horses required on mobilization (only cost is registration and inspection) (say)	5,000
	£756,755

(ii) *Capital.*

Sale of 5,887 animals @ (say) £20 .. .. .. =	£117,740
„ 3,456 H.T. vehicles @ (say) £10 .. .. =	34,560
	£152,300

* This figure includes allowance for depreciation, life of animals being estimated at 7 years.
** These men as Class "A" Reservists are paid 1s. 6d. per day, as Class "B" 1s. Cost varies between £20 and £30 p.a. each.

(*b*) EXPENDITURE.

(i) *Annually.*

Regular cadres (say 5 N.C.O's per big unit and 2 per Field Co., R.E., i.e., 539 @ £120)	=	£ 64,680
Increase in regular M.T., required in peace, say 280 men @ £120	=	33,600
Bounties and training expenses of 3,500 civilian drivers at £25	=	87,500
Vehicle retaining fees, 3,000 @ £20	=	60,000
Running expenses garrison pools of M.T., say 4,000 vehicles @ £40	=	160,000
		£405,780

(ii) *Capital.*

Subsidies on vehicles required (assuming 500 suitable exist now), 3,000 @ £120†	=	£360,000
Increase in Regular M.T. vehicles maintained in peace (say 250 vehicles @ £600)	=	150,000
		£410,000

The annual saving between (*a*) (i) and (*b*) (i) is about £350,000 on infantry, cavalry, Fd. Art. brigades and Fd. Companies, R.E. only. Total saved for *all* regular horsed units at home is estimated to be £400,000 annually, after 1st year.

† Subsidies at present given are £40 p.a. for 3 years.

Thus far, only the question of 1st line transport at home in the British Regular Army has been dealt with. As regards the question abroad, it is an undoubted advantage to have abroad the same organization of transport as at home, *if possible*. Abroad, however, units of the British Regular Army, as opposed to those of Dominion Armies, must be in a state of constant readiness. Further, local civil mechanical transport does not exist to a great extent. The solution would appear to be that in certain stations, such as the N.W. frontier of India, where only certain forms of local transport are practicable, a system of local transport should be organized. In other stations, such as Egypt, Malta, Gibraltar, etc., where at present horse transport and animals are maintained, these should be gradually disposed of in the stations where mechanical transport can operate equally well, and be replaced by mechanical transport from home, manned by regular personnel. This change will cost money, but it is suggested that, for units on the charge of home estimates, this could be met out of the annual savings gained upon the conversion at home. For units borne upon Indian Army estimates, it is a matter for representation to the Indian Government that the changes should be undertaken.

For units of the Dominion forces, which are already largely upon a non-permanent basis, the scheme as suggested for the Army in Great Britain has everything to recommend it.

SODIUM HYPOCHLORITE AND ITS PREPARATION BY ELECTROLYSIS OF BRINE.

By MAJOR A. P. A. LEWIS, R.E.

I AM indebted to Messrs. Mather and Platt for most of the information contained in this article, and for the loan of illustration blocks. I have also obtained much information regarding the applications of sodium hypochlorite from a report by H. D. Dakin, D.Sc., and H. G. Carlisle, M.D., on its use during the Great War on H.M.H.S. *Aquitania*, which was published in the *Journal of the R.A.M.C.* for February, 1916.

1. SODIUM HYPOCHLORITE AS A DISINFECTANT.

The effectiveness of chlorine as a disinfectant is well known. In the Service its most common application is in the form of bleaching powder (chloride of lime), which was used extensively during the war, both for general sanitary purposes and for the sterilization of drinking water.

Bleaching powder possesses certain disadvantages. When freshly prepared it is alkaline, which largely neutralises its disinfectant effect. When kept for any length of time it deteriorates in strength. Hence its strength is always uncertain, and it is, therefore, necessary to use an excess, which besides being uneconomical, results, when it is used for sterilising water, in rendering the water unpalatable. Further, insoluble compounds are formed as a result of its action, which in many cases is undesirable. It is not universally available and cannot conveniently be prepared in small quantities when required.

Sodium Hypochlorite, with at least equal effectiveness, avoids most of these disadvantages. Although unstable (though means of stabilising are available, as described later), and less convenient for transport than chloride of lime, as it is prepared in weak solution, these disadvantages are neutralised by the fact that it can be prepared easily and cheaply in any required quantities at any spot where electric power and common salt (sea water can be used) are available, by means of a small and portable apparatus. The only residue after action is a solution of common salt.

The disinfectant action of chlorine depends on its power of liberating oxygen thus—

$$Cl_2 + H_2O = 2\ HCl + O$$

The free atom of oxygen, being in the nascent state, has a powerful oxidising effect on any organic matter.

The resultant action in the case of sodium hypochlorite may be expressed thus—

$$NaOCl = NaCl + O$$

from which it might be inferred that the chlorine played little part in the action. There are, however, intermediate reactions in which the chlorine plays a part, and there are good grounds for considering it as the active principle of the solution even though it merely acts as an intermediary. It is, therefore, customary to reckon the strength of a sodium hypochlorite solution according to the percentage of "available chlorine."

It will be noticed that whereas two atoms of free chlorine are required to liberate one atom of oxygen, the same amount of oxygen is liberated by only one atom of chlorine in the hypochlorite. For the purpose of estimating the strength of the solution, therefore, a molecule of sodium hypochlorite is considered to contain two atoms of "available chlorine." This explains the apparent anomaly that a 1% solution of sodium hypochlorite is also, approximately, a 1% solution of available chlorine (molecular weight of $NaOCl = 74.5$, of $Cl_2 = 71$).

2. The Electrolytic Process.

Sodium Hypochlorite can most conveniently be prepared by the electrolytic process. This process has been developed by Messrs. Mather and Platt, Ltd., who manufacture electrolysers of various types, from a small one suitable for laboratory use up to the very large plant required to produce the quantity used in bleaching works. It should be noted that although the sanitary application of this process is little heard of, its commercial application is well established and the process is in no way experimental.

The principle of action is, that a solution of common salt is electrolysed between carbon electrodes in a suitable vessel, the temperature being kept below 45° C. (the lower the better). Under these conditions sodium hypochlorite is formed as the result of a number of reactions. These reactions are somewhat obscure, but the following equations may be taken as substantially representing the action :—

By the action of the current, sodium chloride is split up, chlorine being liberated at the anode, and sodium at the cathode. The latter immediately acts on the water and liberates hydrogen—

$$Na + H_2O = NaOH + H$$

The chlorine then acts on the sodium hydrate—

$$2\,NaOH + Cl_2 = NaCl + NaOCl + H_2O$$

At any temperature above about 20° C. a proportion of sodium chlorate is formed, which becomes large enough to be a serious drawback at temperatures above 45° C. Hence it is necessary

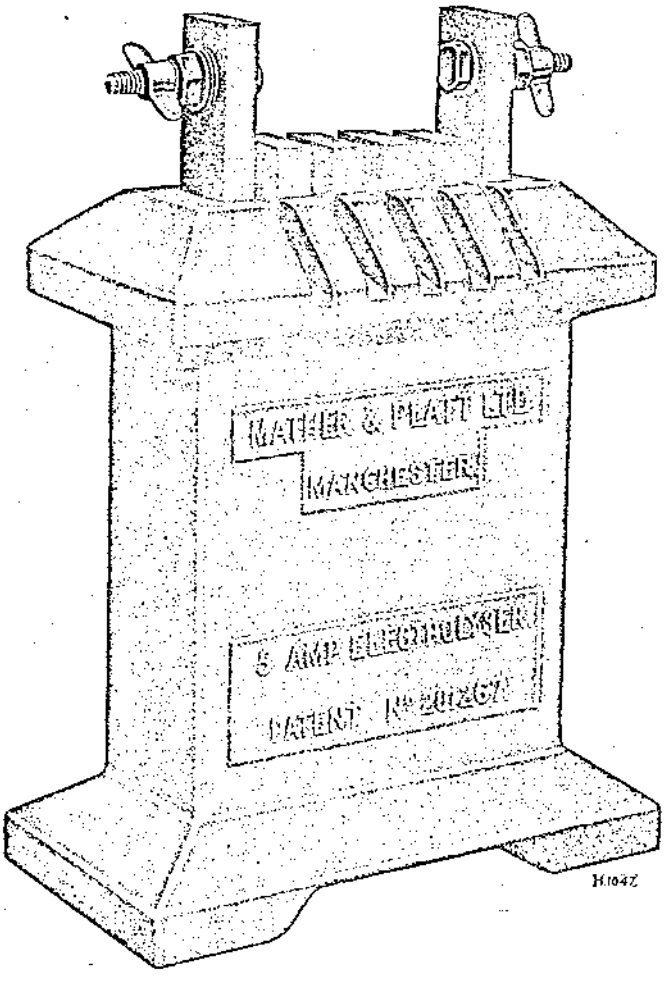


Fig. 2.—5-Amp. Graphode Electrolyser

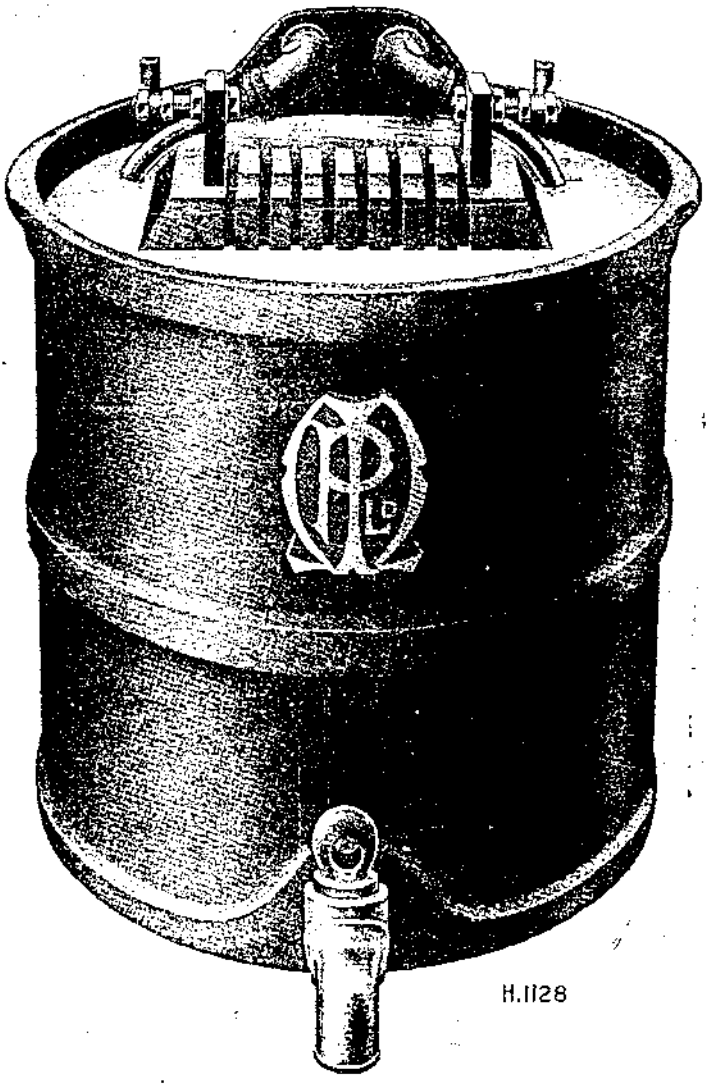


Fig. 3.—30-Amp. Graphode Electrolyser and Container.

to provide cooling arrangements if the action is to be prolonged more than a few minutes, the passage of the current naturally raising the temperature. The reaction by which sodium chlorate is formed can be represented generally by the equation—

$$6\ NaOH + 3\ Cl_2 = 5\ NaCl + NaClO_3 + 3\ H_2O$$

but this cannot be taken as an exact statement.

The types of electrolysers manufactured by Messrs. Mather and Platt are described briefly below, and the more important data are tabulated at the end of this article.

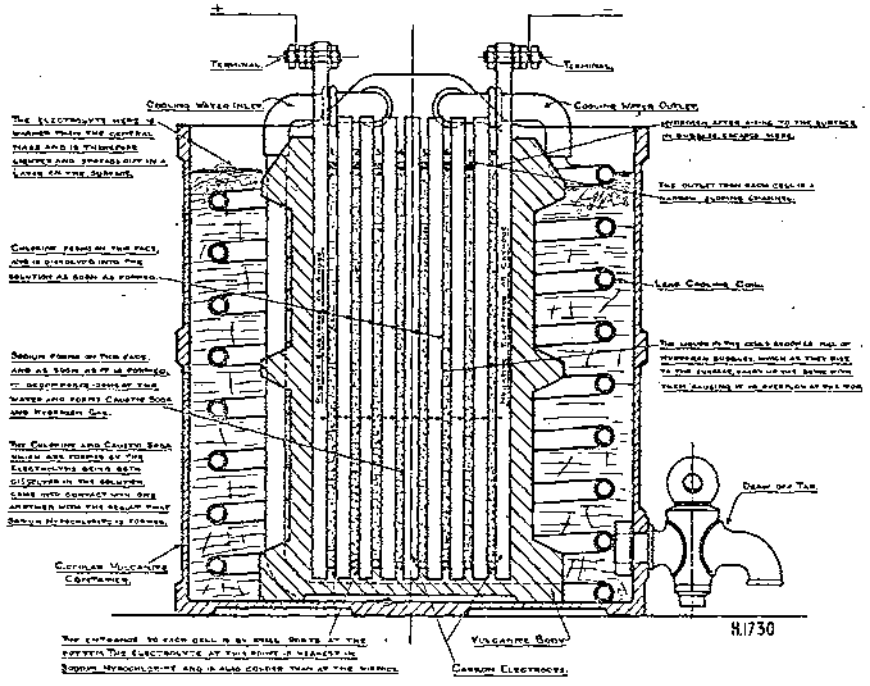


Fig 1.—Details of Graphode Electrolyser.

The Graphode Electrolyser (Figs. 1, 2, 3), is made in four sizes, rated according to current consumption, as 5 ampère, 12½ ampère, 30 ampère, and 60 ampère sizes. The five ampère size consists of a vulcanite holder divided into five cells by graphite electrodes. This stands in a glass container holding about one gallon of brine, and for cooling purposes the whole stands in a teak lead-lined box through which cold water is allowed to pass. The larger sizes are similar so far as the electrodes and holders are concerned, but vulcanite instead of glass containers are used, and cooling is effected by passing cold water through a coil of lead piping immersed in the brine. Modified forms of the 5 ampère, 12½ ampère, and 30 ampère sizes, in which more concentrated solution can be prepared by using a higher current density, are also made.

The carbon electrodes are made of pure Acheson graphite, which is found to be the only satisfactory material. These are slightly affected by the action, but have a good life, 12 months, working a full 8-hour day, being estimated as an average. Used for sanitary purposes the plant would probably be run intermittently for much shorter periods, and the life of the electrodes correspondingly increased. A set of electrodes for Graphode Electrolysers costs from 30s. to £5, according to size.

The only other parts of the apparatus requiring periodical renewal are the lead cooling water pipes, but these have a very long life and can normally be made locally. They become oxidised in time, but the oxide is insoluble and does not contaminate the hypochlorite solution.

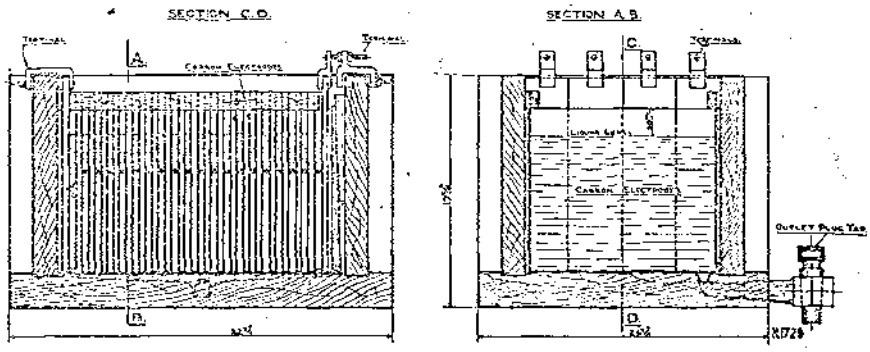


Fig. 4.—Detail of Ships' Electrolyser.

The Ships' Electrolyser (Figs. 4, 5), is specially adapted for use with sea water. This apparatus consists of a strong teak box divided into 20 cells by graphite electrodes. No cooling arrangements are provided, as with the weak concentration produced the action is completed before the temperature rises to an undesirable figure. It is only adapted for producing a very weak solution (see below), but is simple, durable, and robust.

In addition to the above types, Messrs. Mather and Platt make several types of very much larger size for use in bleaching works. These, however, need not be considered from our point of view, the Graphode types being amply large for all military purposes.

The operation of an electrolyser is simple. The container is filled with brine to within an inch or two of the tops of the electrodes (care being taken not to wet the tops of the electrodes, which would cause leakage of current between the cells), the cooling water turned on (except in the case of the ships' electrolyser), and the current switched on for a period of five minutes with a ships' electrolyser, or three to six hours with a Graphode electrolyser. The solution, containing from .25% to 2% of hypochlorite, is then run off into a wooden tub or into coloured glass bottles, and the process repeated

with a fresh solution. Hydrogen is given off during the process, and the temperature of the solution rises.

The strength of the hypochlorite solution which can be produced depends on the strength of the salt solution used, but in any case only a proportion of the salt is acted upon.

It is economical to produce the hypochlorite at a lower strength than is actually possible.

The best strength of the brine is 12½% to 15%. From this it is possible to prepare 2% hypochlorite solution, but for economical working it is best to limit the strength to 1%, which may be taken as the standard hypochlorite solution. When 2% solution is required it is advisable to use a 20% to 25% brine and a higher voltage, with the modified cell mentioned above.

For concentrations above 2% it is necessary to use platinum electrodes. Messrs. Mather and Platt formerly made a small electrolyser with platinum electrodes producing up to 5% solution, but owing to the prohibitive cost of platinum, and the fact that a 1% solution meets all practical requirements, this type has been discontinued.

As stated above, the ships' electrolysers are intended for use with sea water, which is practically a 2½% solution of sodium chloride, and produce a .25% solution of sodium hypochlorite. This meets all requirements where the fluid is used on the spot, and does not have to be stored or transported, so that the extra bulk and weight are unimportant.

The Graphode electrolysers can also be used with sea water and .4% solution can be obtained, but the consumption of electric power is higher for a given output of chlorine than with a solution of the proper strength. The cells also require more attention if sea water is used, owing to the impurities in the sea water, which cause deposits to form on the electrodes. This can be minimised by reversing the current daily.

When sea water is available, it is necessary to balance the cost of salt (which can be of the cheapest grade), against the additional electric power required by sea water, in order to decide which solution to use. A compromise which may be satisfactory in many cases is to use sea water to which 2½% of salt has been added. A .4% solution of hypochlorite can be obtained from this with fair economy of power.

A suggestion for tropical stations (which does not appear to have been tried) is to evaporate the sea water to the desired strength in the sun. Possibly the concentration of the impurities would have undesirable effects.

Examples of results obtained with different concentrations are given below. The suitable solution for any given case depends, of

course, on the local cost of salt, and of electric power. These results were obtained with a 12½ amp. size Graphode Electrolyser,

(*a*) using sea water.
(*b*) using sea water to which 2½% of common salt was added.
(*c*) using 12½% salt solution.
(*d*) using 20% salt solution.

	(*a*)	(*b*)	(*c*)	(*d*)
Strength of salt solution ..	2½%	5%	12½%	20%
Voltage	110 v.	70 v.	40 v.	50 v.
Current	12.5a.	12.5a.	12.5a.	12.5a.
% of available chlorine ..	.4%	.4%	1%	2%
Kilowatt hours per lb. of available chlorine ..	11.7	5.5	5.0	6.7

In case (*d*) a modified cell, as mentioned above, is used with a higher current density.

Using the ships' type electrolyser a current of 75 amps. at 100 volts produces .25% solution from sea water for an expenditure of about 4 k.w.h. per lb. of available chlorine. As no cooling arrangements are provided, the action should not be continued longer than 5 minutes, which is sufficient to electrolyse the contents of the vessel (6 gallons), to the above strength.

3. Stability of Solution.

As prepared, the hypochlorite solution is unstable, and should be used within 48 hours. As it can be prepared daily as required, this usually matters little, but if it is necessary to store it for some time it can be stabilized by the addition of 1% of lime. This does not affect the action of the chlorine, and an excess will do no harm.

The cause of instability is somewhat obscure, but appears to be the formation of carbon dioxide in minute quantities by the action of the chlorine, in the presence of water, on the carbon electrodes. The following equations, while not pretending to give the exact reactions, probably represent the general trend of events—

$$Cl_2 + H_2O = 2\,HCl + O$$
$$2O + C \quad = CO_2$$

The carbon-dioxide reacts on the hypochlorite thus—

$$CO_2 + H_2O + 3\,NaOCl = Na_2CO_3 + 2\,HCl + NaClO_3$$

This action takes place during electrolysis and merely reduces the final strength of the solution, but an excess of CO_2 produces sodium bicarbonate which, being an acid salt, gradually continues the action on the hypochlorite after electrolysis is complete. The addition of lime neutralises the acid salt.

Solution prepared with platinum electrodes is stable, as these reactions are avoided. The stabilised fluid will maintain about 80% of its original strength after six months' storage, provided the solution is kept cool, and dark coloured bottles are used.

4. Applications of Sodium Hypochlorite.

The applications of the sanitary fluid are for the consideration of the medical authorities rather than the engineers, but a brief resumé may be given.

As a disinfectant a 1% solution has a phenol co-efficient of 4.4. A solution of 1/1,000,000 will kill germs (other than spores), in two hours if other organic matter is not present.

In the presence of organic matter, a strength of 1/500 to 1/2000 may be necessary for a complete sterilization. A solution of 1/1000 is suitable for most sanitary purposes.

A .25% solution will kill anthrax spores (which are among the most difficult to kill), in 15 minutes.

The addition of 1 part of 1% solution to 10,000 parts of drinking water will sterilize it without affecting the taste, and is in every respect preferable to bleaching powder for this purpose.

The 1% solution may be diluted 50 times for washing infected vessels, or 100 times for floors, etc. Diluted 500 times it is useful for freshening the air of a building, even if no infection exists. As a deodorant for meat stores it is very useful. It can be used in the laundry, and besides its disinfectant action it has the effect of loosening dirt, and it also bleaches.

The electrolysers were used during the late war on hospital ships, the sanitary fluid being used for all the above purposes. They are still used on all the Cunard vessels, and many other large ships.

Another use for Sodium Hypochlorite is for freshening the water of swimming baths. Public swimming baths rapidly become polluted in use, the temperature of the water being most favourable to the development of organisms; the water grows dark in colour, and has an offensive odour, and slime forms on the bottom of the bath. The pollution is quite noticeable in 24 hours. In most cases it is out of the question to change the water every 24 hours (involving not only the supply, but the heating of the fresh water).

The addition of 1 in 2,000,000 parts of Sodium Hypochlorite to the bath water reduces the organisms by 99%, clears the water, and removes the offensive smell without any ill effects. The water feels much fresher and more invigorating to bathe in than the untreated water. It has been used for this purpose for some years in the public swimming baths in the borough of Poplar.

5. Effect on Structures.

One drawback to the use of sodium hypochlorite for general sanitary purposes is its corrosive effect on metals, and to a less extent on other structural materials. This, however, is not a serious trouble. Iron and steel, bare, are corroded badly, but paint has proved an efficient protection. Copper is corroded slowly, but appreciably, brass rather less. Other common metals are but little

affected, lead being the most resistant. Tin plate, nickel plate, or galvanised iron, may be considered practically immune if the plating is intact. Wood is acted on by the fluid but without appreciable effect on its structural strength. It was found on H.M.H.S. *Aquitania* that no significant damage was done to any part of the ship in two months, during which period the fluid was extensively used for washing out wards, corridors, etc.

6. Military Uses of Sodium Hypochlorite.

Apart from their use on Hospital ships, as mentioned above, the electrolysers do not appear to have been used at all for military purposes. They appear, however, to have considerable possibilities.

For active service a portable plant capable of producing sanitary fluid as and when required, would be extremely valuable. Large quantities of bleaching powder and other disinfectants were used during the late war, and, as has already been shewn, the electrolytic fluid is in nearly every case preferable, if it can be produced on the spot. Unless a source of electric power exists already, it would probably not be economical to carry electrolysers, as the small consumption of power would not justify carrying a special power plant. But all forces of any size in the future will require power plant for various purposes (search-lights, wireless, etc.), and the electrolysers could well be added to one of these plants.

For active service the Graphode Electrolyser with vulcanite container and lead cooling coils, although strongly made, does not appear to be ideal, as portability and durability under rough handling are essential. A carrying cradle could be designed to improve portability. The ships' type is more suitable, but as it will normally be convenient to use full strength salt solution, a modified—possibly smaller—form, of similar construction would probably be most satisfactory, and could no doubt be produced if required in large numbers. Some means of cooling would be necessary.

In peace time the most useful application appears to be for tropical stations, where drinking water has to be purified, and large quantities of disinfectants are used for general purposes. Many of these stations have defence electric light plants, including 60 volt secondary batteries, which are little used under ordinary peace conditions. Regular use is beneficial to a secondary battery, and whether used or not, it requires to be regularly charged to keep it in good condition. The electrolyser could, therefore, be run from these batteries without any additional expenditure of power, and could easily be looked after by the sapper in charge of the battery, the attention required being very simple.

Where no defence electric lights exist, some other source of power is almost certain to be available. If there is a general supply of electric light to the barracks, the electrolysers would probably be

installed at the hospital and run from this supply, but it should be noted that if the supply is alternating it will be necessary to instal rectifying plant.

For peace purposes, the Graphode type seems suitable. The vulcanite container might, perhaps, be expected to give trouble in very hot climates, but in practice this has not been found to be the case; some of this type have been in use in India for a considerable time without developing any defects. If a special military type was produced it might be more convenient to use it for peace purposes also. One type and size, not too large, and capable of being run off the 60 volt batteries, would probably meet all requirements for peace and war, being used in sets where the supply is of a higher voltage, e.g., four electrolysers in series on a 230 volt supply.

To give an idea of the size of the plant required, the Borough of Poplar, making extensive use of the fluid for all purposes, and selling large quantities to the public within the borough, uses five 30 amp. Graphode electrolysers.

This plant, or its predecessor, of French make, supplied all military establishments in the borough during the war.

7. Costs.

As a rough guide to costs, I give the prices of a few typical sets.

The 5 amp. Graphode with switchboard, regulating resistance, and all accessories, costs £45. A spare set of electrodes costs 30s. A set of four 60 amp. Graphodes, with accessories, costs £450. New electrodes would cost £20.

A ships' type electrolyser and accessories costs £60.

The running costs depend, of course, on the local cost of current and salt; the costs in the Borough of Poplar, covering 20 years' working, during which time 1,250,000 gallons of 1% fluid have been produced, come to 3d. per gallon, including wages, cartage, rent, etc., but with the present plant the costs are reduced to 1.6d. per gallon.

8. Weights and Packing Dimensions.

Type.	Net weight.	Gross weight.	Packing Dimensions.
5 amp. Graphode (complete as above)	1 cwt.	2 cwt.	15 cu. ft.
60 amp. Graphode	2¼ cwt.	4½ cwt.	30 cu. ft.
Ships' type	3¾ cwt.	6 cwt.	30 cu. ft.

PARTICULARS OF GRAPHODE AND SHIPS' TYPE ELECTROLYSERS.

Size.	5-amp.	12½-1mp.	30-amp.	60-amp.
No. of cells	5	8	8	9
Volts required	22-24	40-45	40-45	47-55
Current	5 amps.	12.5 amps.	30 amps.	60 amps.
Strength of salt solution ..	12½% to 15%	12½% to 15%	12½% to 15%	12½% to 15%
Percentage of available chlorine	1%	1%	1%	1%
Production per hour ..	¾ gall.	1.4 gals.	3.5 gals.	8 gals.
Material of Container ..	Glass inside a teak lead-lined box.	Vulcanite.	Vulcanite.	Vulcanite.
Cooling system	By passing cold water through the outer box.	Lead cooling coils.	Lead cooling coils.	Lead cooling coils.

Size.	5-amp. Special.	12½-amp. Special.	30-amp. Special.	Ships' Type.
No. of cells	5	8	8	20
Volts required	28-33	50-60	55-70	110
Current	5 amps.	12.5 amps.	30 amps.	75 amps.
Strength of salt solution ..	20% to 25%	20% to 25%	20% to 25%	2½% (sea water)
Percentage of available chlorine	2%	2%	2%	.25%
Production per hour ..	¼ gal.	8 gal.	1.75 gal.	6 gals. in 5 minutes
Material of Container ..	Glass inside a teak lead-lined box.	Valcanite	Vulcanite	Teak
Cooling system	Passing cold water through outer box.	Lead cooling coils.	Lead cooling coils.	None fused for 5-10 minute runs only).

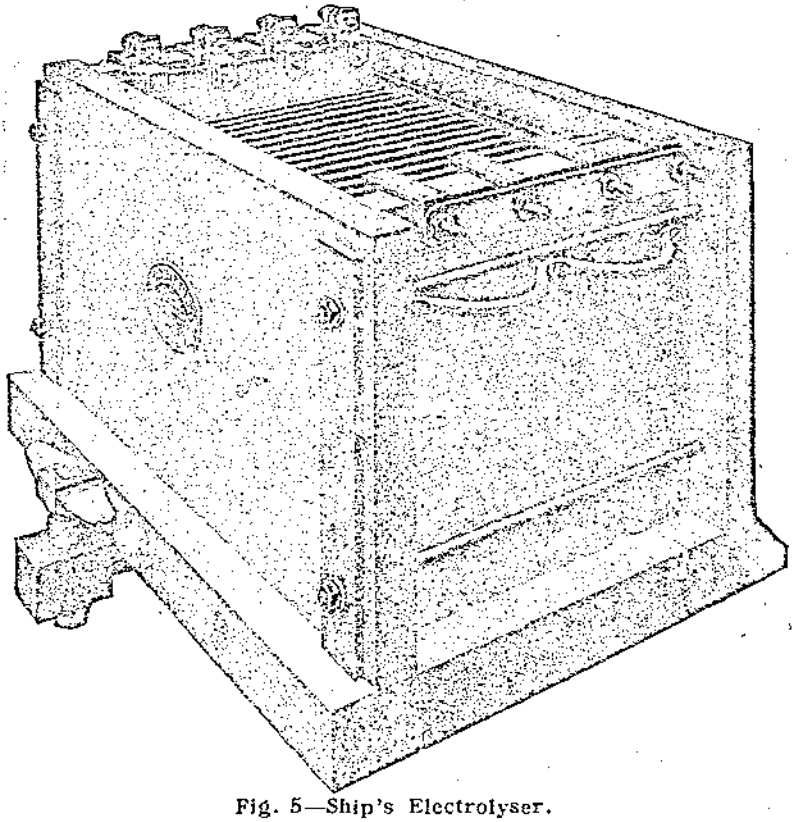


Fig. 5—Ship's Electrolyser.

"FISH, FLESH, OR FOWL?"

By Lieut. J. V. Davidson-Houston, R.E.

A.—Introduction.

What is the Tank?

How are we going to use it, and what are we going to do when the enemy uses it?

Whenever a so-called new arm appears, such questions exercise the minds of all, an argument which affords some measure of justification to an expression of opinion on the part of a junior officer.

To the mind of the present writer, it appears that throughout the history of warfare, there has existed a definite number of arms, each bearing a fixed relation to the others and preserving its characteristics despite all mechanical advancement.

Let us examine the following table, in which the various weapons known to military history have been sorted into their categories.

Characteristics of Various Arms.

(1) Armoured Heavy Shock Troops, proof against "small-arm" fire, and capable of moving over most ground.	Chariots. Armoured Knights. Tanks.
(2) Light Shock Troops, more mobile, but developing less fire power than (4).	Mounted Archers. Cavalry.
(3) Machines casting heavy projectiles, used to silence enemy fire or destroy defences.	Rams. Ballista. "Ordnance." Artillery.
(4) Men carrying weapons with which they can attack the enemy at a distance or hand-to-hand over any ground. "The arm that in the end wins battles."	Archers with Spearmen. Musketeers with Pikemen. Infantry.
(5) Men to undertake skilled work in every operation of war.	Artificers. Engineers.

If we accept this premise, we see that there are five types of fighting men, which may be classified as follows:—

(1) Heavy Shock Troops.
(2) Light Shock Troops.
(3) Projectile Throwers.
(4) Fire-and-movement Troops.
(5) Engineers.

B.—THE FIVE ARMS.

(1) *Heavy Shock Troops.*

The chariot, often provided with scythed wheels and carrying one or more armoured fighting men, must have dismayed an enemy against whom it was used for the first time.

Its fighting and moving parts were proof against the small-arm fire of the period, and it could "destroy hostile weapons and personnel by passing over them" (*cf. F.S.R. Vol. II. para.* 16 (2)). Elephants and armoured wagons were also employed by various armies, but in every case the defence at length found a suitable reply.

Heavy shock troops had only to be immobilized by obstacles or by wounding the animals supplying their motive power; they were then at the mercy of the opposing troops, and could be destroyed at leisure.

When all well-equipped forces had come to be provided with chariots, a more mobile form of heavy shock troops was introduced in the shape of armoured men mounted on ponderous armoured horses. This, the chivalry of the Middle Ages, met its doom with the invention of gunpowder.

Because no means were forthcoming whereby shock troops could be made proof against bullets, this arm disappeared from the battle-fields of Europe for over four hundred years.

The twentieth century has produced once more an armoured fighting vehicle that is proof against small-arm fire—the Tank.

(2) *Light Shock Troops.*

It is curious to reflect that men fought from chariots before they fought on horseback. The prototype of the cavalryman was the mounted archer, employed chiefly by "barbarians" in classical times, whose functions in the pursuit and retreat in general resembled those of the modern arm. Horsemen have also always been employed, on account of their speed, for reconnaissance work.

This arm must be considered as distinct from heavy shock troops, since weight, and not mobility, was the chief characteristic of the latter.

The steady fire of well disciplined men has proved an effective answer to assault by these troops, and the increased accuracy and fire power of modern weapons has almost eliminated their use in the main attack on a position.

A weapon, however, has now been produced, which, in this early stage of its development, is yet capable of doing much of the work of cavalry—the Tank.

(3) *Projectile Throwers.*

Ever since men began to throw stones at one another, the advantage has lain with him who could cast the heaviest and most destructive missile.

The sling was followed by the catapult, and ancient writers tell us that engines were employed which could throw the decaying corpses of men and horses into an invested city, for the purpose of poisoning the inhabitants.

Battering rams and tunnelling were made use of in order to destroy the enemys' defences, but solid building was found to be an adequate defence against this form of attack.

The invention of gunpowder, which was a development at least as revolutionary as the coming of the Tank, did not "reform" war. The cannon and the explosive mine merely hit harder than the older weapons, and were successfully countered by the increased solidity of fortifications, and by the skill in tactical handling and use of ground by troops, who increased their mobility by discarding their armour.

The ever-growing mobility of armies means the necessity for artillery to accompany the force they are assisting over any ground, at great speed and for distances which will be exhausting to horses. This state of affairs has led to the attempt to arm tanks with light guns (e.g., "pom poms"), so that they may support the advance of infantry where horse-drawn artillery, on account of their vulnerability, would fail. It has also led to the invention of the tractor as a substitute for a gun team, and we may shortly see field guns mounted on cross-country vehicles—another type of Tank.

As the fire power of artillery increased, it was found that augmenting the solidity of defences against high explosive shells was as uneconomical and as useless as loading the fighting man with bullet-proof armour. A position is now held with the minimum number of troops so that artillery preparation can do little damage, and the main forces of the defence are kept in hand to deal with the enemy when his infantry attack has been launched.

(4) *Fire-and-movement Troops.*

We have seen that the invention of explosives has rendered the wearing of body-armour impracticable; we have also seen that it is becoming increasingly difficult for flesh and blood to live and move on a modern battlefield.

Infantry, by the skilful use of ground, and a defence built up on a framework of obstacles, artillery, and machine gun fire, can hold a

position against any form of attack. Chariots, elephants, armoured horsemen, or tanks, once immobilized by the careful siting of ditches, palisades, wire, or land mines, or driven by them into avenues raked by the defenders' fire, are doomed.

As success, however, can only be won as a result of offensive action, these fire-and-movement troops have got to move on the modern battlefield. Aerial activity, the range and accuracy of the enemy's artillery, and the rapid movements of hostile tanks necessitate an increased mobility on the part of infantry.

The logical outcome of all this is that the arm must be moved about the field in fast armoured vehicles, provided with machine guns so that it may develop fire while in motion, and armed with the rifle and bayonet in order to close with the enemy troops, and to send back its vehicles when no longer required. It is important to remember that an armoured vehicle cannot effectively fight when at rest.

This system fulfils the principle of economy of force, as well as that of mobility and concentration, since a section of men in a tank is at least the equivalent of a platoon of unarmoured infantry.

(5) *Engineers.*

These troops must be present in every part of the theatre of War, and with every fighting formation, since their duty is to undertake or assist in the execution of skilled work in all operations. Their mobility and degree of protection must be the same as that of the forces to which they are allotted; their men and their technical equipment must also be carried in armoured cross-country vehicles.

C.—THE TANK.

Ever since its inception, one type of tank has been employed to do the work of each of the five arms.

It has been used as heavy shock troops to disorganize and destroy an enemy by a frontal charge; as light shock troops, by manœuvring on the flanks and acting as a mobile reserve; as a projectile thrower, for which purpose it has been equipped with guns discharging a shell; as an integral part of the infantry assault, destroying obstacles and supplying covering fire; and as the well-known "R.E. Tank," which was a mobile crane and tractor.

It seems that the tank must either be a new weapon, whose proper application has yet to be decided, or else it is in fact capable of undertaking the functions of all the known arms.

We cannot envisage any activity of the tank which is not characteristic of one of the five arms already discussed; on the other hand, the weapon as we know it cannot be suitable for the undertaking of every operation of war.

Whatever the mobility of a force, a proportion of it must be capable of faster movement than the remainder; otherwise operations involving reconnaissance, protection and surprise cannot be adequately performed. A mechanicalized army must still possess a number of troops with the same relative mobility as cavalry.

For this and analogous reasons, we shall see the evolution of the "Cavalry Tank," the "Infantry Tank," the "Fire-power Tank," and so on.

D.—Conclusion.

We have tried to find an answer to the question:—"What is the Tank?"

The writer ventures to express the opinion that it is merely the donning of armour and increasing mobility all round, as an answer to the use of heavy immobile artillery; an answer which has been delayed for four centuries for the want of a means to move the troops so heavily protected.

Let us amend our manuals, not scrap them.

WELL-BORING.

By LIEUT. J. B. GURNHILL, R.E.

Prior to the Autumn of 1925 it had been decided to open a training Centre for certain of His Majesty's Forces at a site some four miles south of town Z (see Fig. 2).

There existed already at this site a disused war-time Camp which embodied, besides many useful buildings, certain features very suitable for the present requirements.

It was decided to convert this old Station into one which would suit requirements, to recondition, and in many cases to re-adapt the present buildings, and to add several new buildings and plant as necessary.

By the end of November, 1925, a very good start had been made in the work of conversion, which it was estimated would take about 12 months to complete.

The Camp lies, as will be seen by reference to Fig. 2., on comparatively high ground, and is situated almost immediately eastwards, and on the top of a very definite and steep declivity or escarpment —the outcropping of a limestone stratum.

This escarpment runs approximately due north and south in the neighbourhood of the Camp, and the ground surface, in this part of the country, falls gradually from the escarpment in an easterly direction.

In developing the old Station to suit the new requirements, one of the first essentials was to make provision for a good and ample water supply, it being estimated that the amount of water required for all purposes would be in the neighbourhood of 15,000 to 20,000 gallons a day.

The old Camp had, during the war, its water supply by pipe-line from Town Z Corporation Water Works—a pipe-line of some 2½ miles in length; this, however, had been sold and taken up soon after the war.

To avoid, if possible, the expense of providing and laying a new pipe-line from the Town Z Water Works Reservoir, and for other reasons mentioned below, it was decided first to make every endeavour to find a natural supply of water at the Station itself.

Geologically, it was known that the Camp stands on a top stratum of limestone—then of uncertain thickness—this stratum being of a water-bearing nature.

This being so, it was decided to have several trial bore-holes drilled in the Camp area, and in the event of water being found in reasonable quantity at any of the trial holes, then to sink a 5ft. well, and, if necessary, drive horizontal galleries at the bottom of the well into the water-bearing stratum.

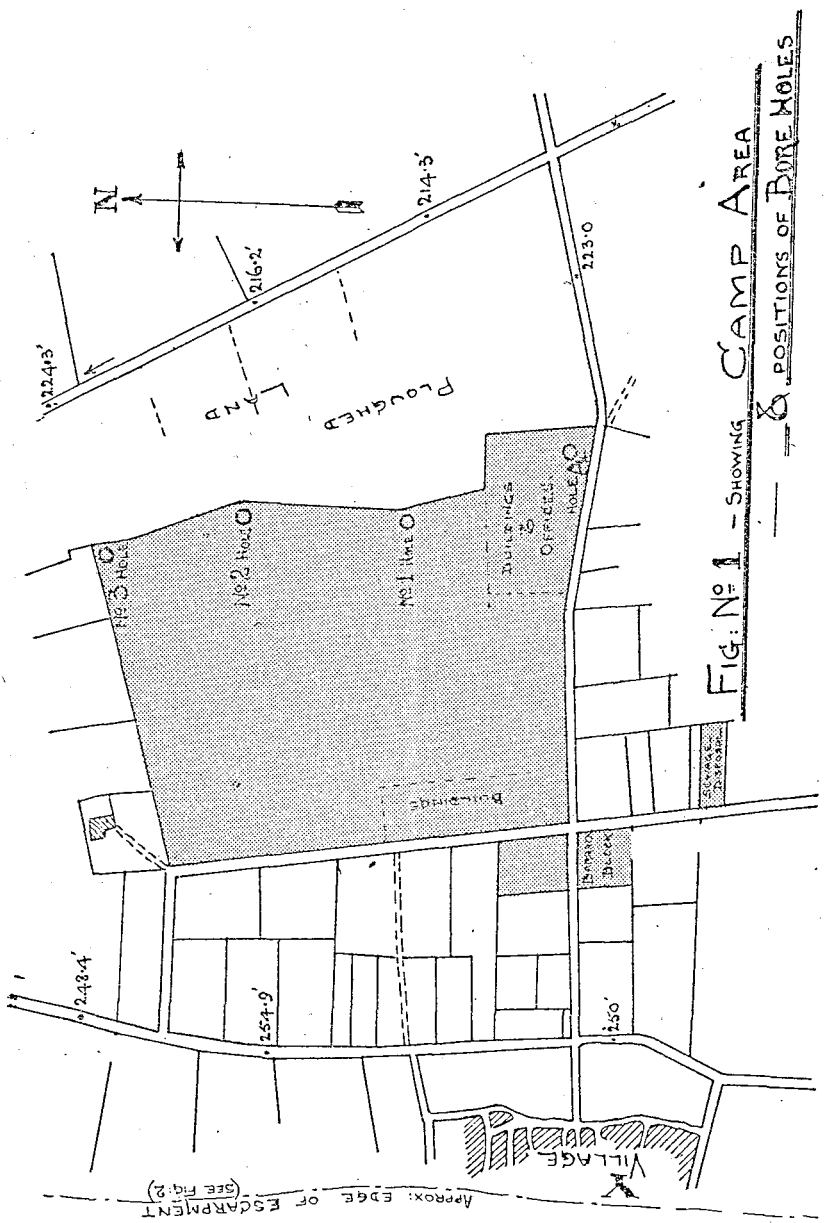


FIG: No 1 – SHOWING CAMP AREA & POSITIONS OF BORE HOLES

If the Station could obtain its own water, on the site, from below ground, this would :—

(a) render unnecessary the costly provision of a 5in. pipe-line, 2½ miles in length ;

(b) cut out a considerable annual charge for Town Z Corporation Water ;

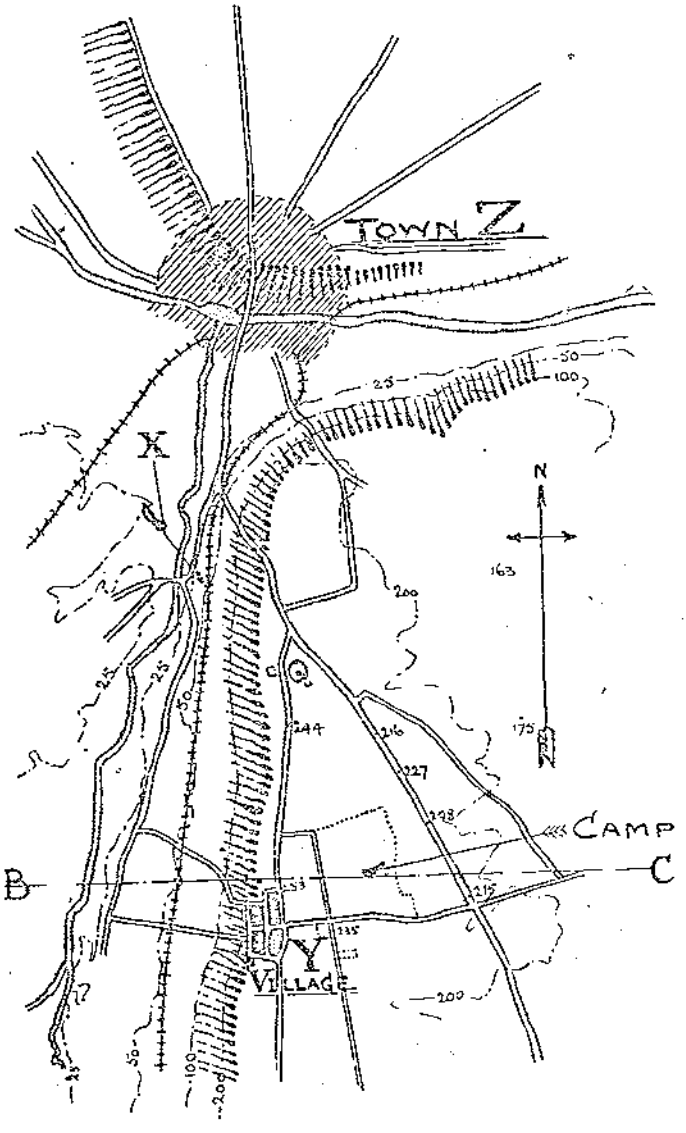


FIG. № 2 — SHOWING POSITION OF CAMP AREA IN RELATION TO ESCARPMENT RUNNING NORTH AND SOUTH

(c) in times of emergency have the advantage of making the Station independent of civilian water supplies, and relieve the military of the responsibility for the protection of the vulnerable pipe-line.

Referring to Fig. No. 1, a bore-hole had been sunk during the war at a point A, in the south-east corner of the Camp area, to a depth of about 90 feet. This had met with no success as regards the striking of water. The information then gained showed that, at that point, below a top layer of some 25ft. of limestone, clay existed to a depth of 90 feet.

Opinion was inclined to the belief that this bore-hole had been unfortunately sited and had been drilled in a "pocket" of clay, so that it was decided to have three trial holes drilled at points No. 1, No. 2 and No. 3 (Fig. No. 1). These trial holes were to be at least 100ft. deep to give the necessary information as to where would be the best site, should sufficient water be found, to sink a 5ft. well.

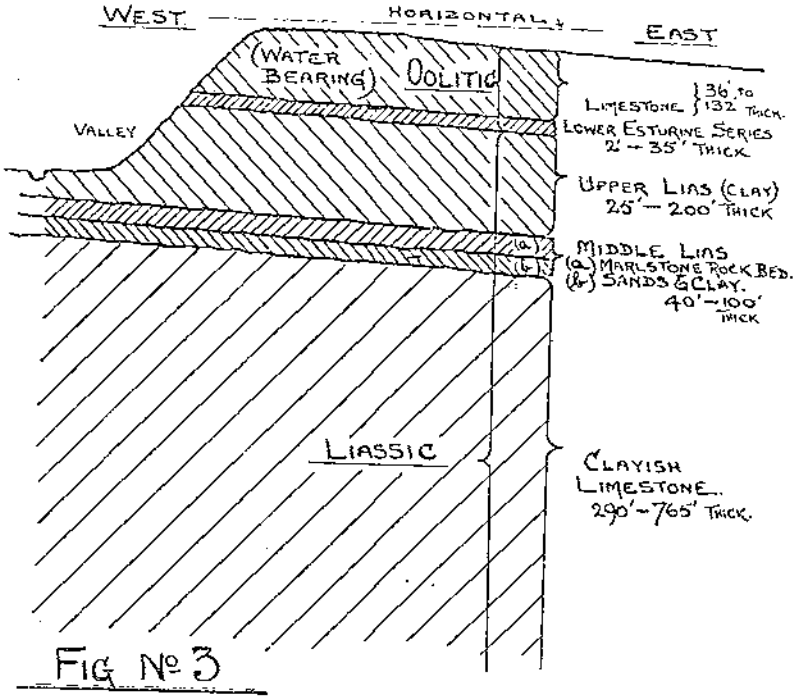


FIG Nº 3

VERTICAL SECTION ON LINE BC (SEE FIG: 2)
(NOT TO SCALE)
ASSUMED GEOLOGICAL SECTION AT Y VILLAGE FROM INFORMATION GIVEN BY THE GEOLOGICAL INSTITUTE.

It will be noticed that the trial bore-holes were to be drilled at equal intervals along the edge of the Camp area, *as far east as possible.*

The reason for this last requirement lies in the fact that the surface of the land, in the neighbourhood of the Camp, has a gradual fall from west to east (see spot levels on Fig. 2). It was assumed therefore that the surfaces of the various sub-strata also slope in the same direction (see Fig. 3). This meant that all rain which fell on the top stratum (limestone) or its out-crop, or on the out-crops of any water-bearing strata below, would in course of time find its way in a direction from west to east. Therefore in boring for water in this particular geological formation, the further east the greater the possible supply.

Rather than have the well-boring work carried out by civilian contract, it was decided to drill the trial holes by military personnel and W.D. plant.

The War Office, on December 8th, 1925, approved of the work being carried out through the Commandant, S.M.E., and the Chief Instructor E. and M. School thereupon undertook the necessary arrangements.

A (N.C.O.) Well-boring Instructor, and Crew (usually 4 Sappers) were, as it happened, immediately available, having just completed a S.M.E. Well-boring Course. The only available machine was an old "Keystone," which had just been in use at the S.M.E. on the above-mentioned Course. This machine, before it could be sent out, needed a thorough overhaul and the fitting of a new boiler.

The preliminary arrangements included a visit to the office of the Director-General of Geological Survey, in order to obtain what information might be available there as to the nature and thicknesses of the sub-strata at the Station.

The Geological Survey Authority unfortunately had no exact information with respect to the Camp, the nearest Geological Section in their possession being of a bore no nearer than at a point X (see Fig. 2) in the river valley. The point X is some 3 miles north of, and about 225 feet below, the Camp site—in fact, well below the out-crop of the limestone.

However, Fig. 3 shows the information gathered with respect to the assumed Geological Section at the Camp; and it will be noticed that the respective thicknesses of the sub-strata were expected to vary within certain limits.

With regard to the prospect of finding water in any sufficient quantity, reconnaissance showed that in the neighbouring village Y, i.e., on the "cliff" edge and immediately east of the out-crop of limestone (see Fig. 2), most of the dwelling houses and farms had their own wells (sunk in this soft rock) which gave all the water required from them.

It was hoped, therefore, that on the Camp site a certain amount of water would be struck in this top stratum, since the bore-holes were to be located nearly a mile-and-a-half east of the village. Also that water might possibly again be encountered in the Middle Lias Stratum (marlstone above sand and clay—Fig. 3).

Preparations were at once set on foot to carry out the necessary overhaul of the "Keystone" Well-boring Machine mentioned above, this machine being of the Percussion type. The collection of the necessary tools and equipment was also put in hand.

In view of the fact that the bore-holes were, primarily, only to obtain information, the bore was to be of the most convenient size which would give quick drilling, and also allow for a step-down in diameter to be effected should trouble be met with in forcing down casing—or in any other way. It was decided, therefore, to start drilling an 8in. hole, and take also the necessary drills and tackle to drill a 6in. hole.

In view also of the fact that the bore-holes were to be of a trial nature only, i.e., were not to be used in connection with an Air Lift Pump or for similar purposes, it was only necessary to provide and have in readiness sufficient casing to enable drilling to be continued, should trouble occur due to the sides of the bore-hole falling in, or being of an unstable nature.

It was decided therefore to take 50ft.-run of 8½in., and 50ft.-run of 6½in. casing. The type of casing provided was the Socketed-Joint Drive Casing (Steel) (see Fig. 4). This is, for general purposes, a very suitable and convenient type. Each length (about 12 feet) is tapered towards the ends, so that the outside diameter of the socket is the same as the outside diameter of the pipe.

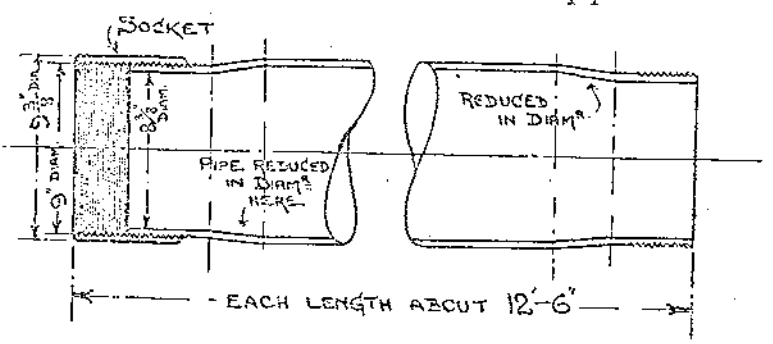


FIG. No. 4.
TYPE OF CASING USED
("SOCKETED-JOINT DRIVE CASING")

Apart from the above, the ordinary set of well-boring tools and equipment were to be taken: these, however, included a few of the standard and more normal fishing tools.

The "Keystone" Well-boring Machine is self-propelling, but is by no means suitable for travelling long distances over hard road surfaces. It has a very low gear ratio in the drive and can move successfully over rough and fairly soft ground. Due to these considerations, there was no question of sending the machine by road under its own power.

The machine and accessories were sent off by rail from Gillingham on December 30th, 1925.

The Well-boring Crew—1 N.C.O. (Instructor) and 4 Sappers—arrived at the Camp on January 2nd, 1926, and were accommodated in billets, there being no other suitable accommodation, at that time, nearer than some barracks 6 miles distant.

Tools and accessories arrived at the Camp Railway Station on January 5th and the "Keystone" Machine at Town Z the day after, when the machine was off-loaded. It was, the following day, towed by road out of Town Z by a 3-ton motor lorry, two lorries being required on the hill up from the river valley to the high ground at Y village.

It had been decided that operations should be started at hole No. 2 (see Fig. 1), as this lay in a slight depression, and was thought to be the most likely of the three holes. Also it was thought advisable to commence drilling in a spot well away from the original bore-hole A, which was thought to have been sunk in a "pocket" of clay.

The lorries had no difficulty in towing the heavy machine as far as the edge of the Camp area, where, however, all metalled road and asphalted area ceased. An attempt was then made to tow the "Keystone" across the Camp area to site No. 2 by means of the two lorries. This at once proved to be impracticable, due to failure of the lorry wheels to grip, and it was evident that the machine would have to propel itself across the 1,000 yards of stubble of the Station area, into position at hole No. 2.

Water and coal were at hand—carted from the village by local contractor—the boiler was primed, steam was raised, and a start was made across the stubble at noon on January 8th. It was not however, until 4 p.m. that day that the "Keystone," after many anxious moments, reached its destination, delay being caused by the sinking in of the driving wheels at several soft spots on the way across. The supply of water for the boiler, during these 4 hours of heavy work for the engine, was somewhat of a problem. The boiler had injector feed only, and water was brought along in a 5-gallon drum through the agency of a small private car doing many journeys to and fro, across the stubble, following up the "Keystone" in its precarious advance.

The "Keystone" was duly set up and got ready for drilling No. 2 hole, a start being made on the afternoon of January 9th. An 8 in.

rock drill (see Fig. 5) was selected to start drilling with, it being known, from examination of some shallow quarries nearby, that under a surface layer of brown loam, and at a depth of about 4 feet, limestone rock would be encountered.

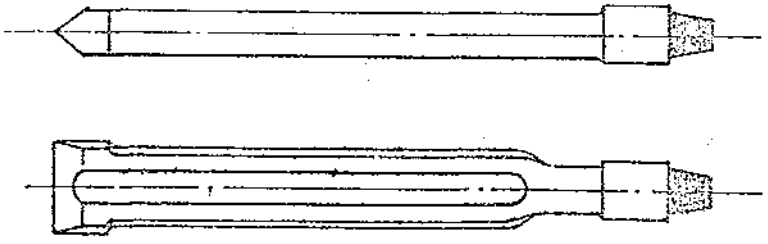


FIG No 5.
ROCK DRILL

A reference to Fig. 6 will show the main features in the drilling of this (No. 2) hole—the progress made, strata passed through, casing driven, etc.

At a depth of 15 feet below ground level, and in the limestone stratum, a small quantity of water was struck (about 80 gallons per hour only), which slowly rose to 8 feet below ground level.

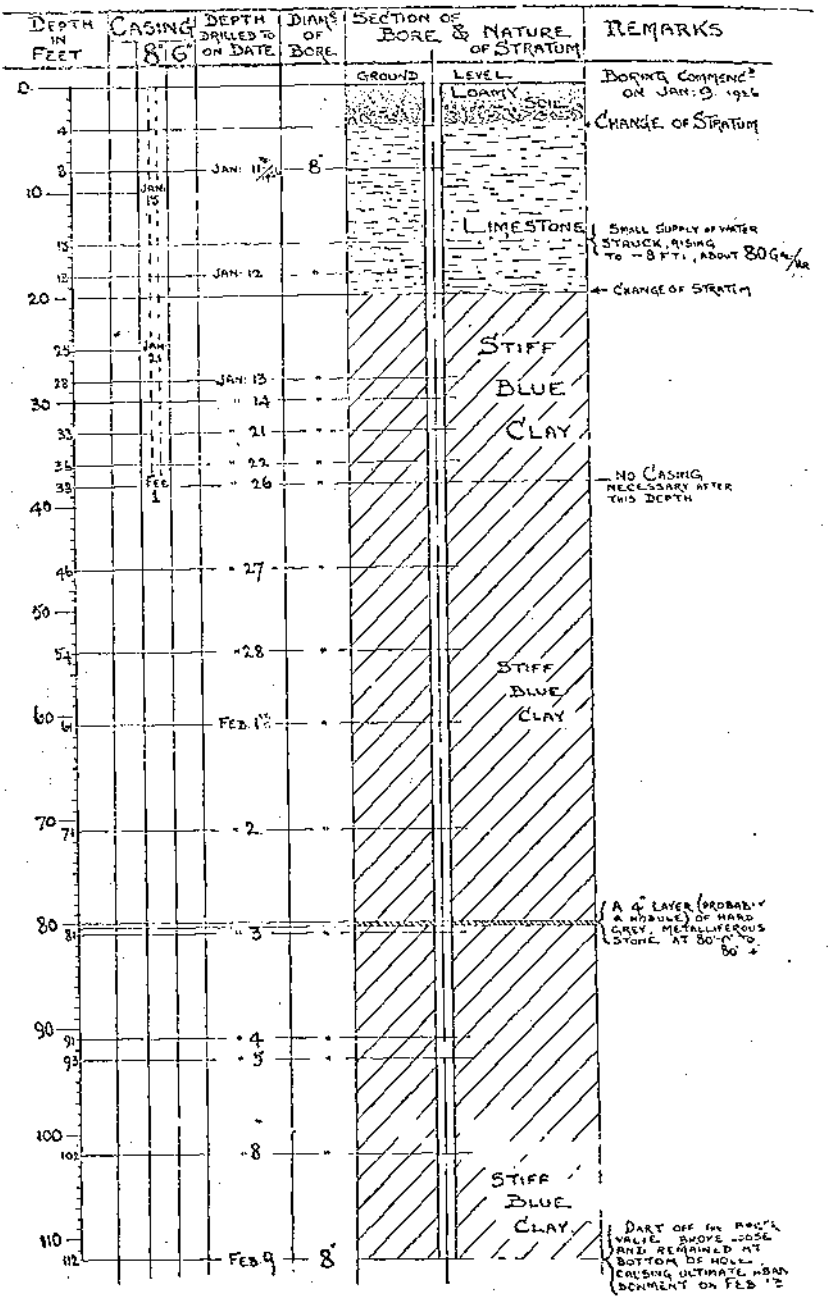
This water was very soon the cause of some delay, since at this level, 8 feet, the sides of the bore, being soft soily limestone, very soon became washed away, due to the churning action of the manilla cable working up and down through the water.—see Fig. 7, showing diagramatic effect of "Water-wash."

To remedy the above, one length of 8½in. Casing was driven down, the sharp-edged cutting-shoe screwed on to the lower end of the casing being very necessary and effective in the limestone stratum. Later, two more lengths of casing were connected and driven, so that, in all, this bore was cased to a depth of 38 feet, water from the limestone stratum being thus effectively kept out; thereafter the sides of the bore gave no further trouble by falling in.

It had been anticipated, from the information collected at the Headquarters of the Geological Survey, that the thickness of the limestone "cap," or top stratum, would be in the region of, at least, some 30 to 35 feet, and it was a disappointment to leave the limestone behind at a depth of only 20 feet, and to enter a stratum of stiff blue clay, which is, of course, entirely non-waterbearing. However, boring was continued to a depth of 100 feet—the depth originally specified.

Having reached a depth of 100 feet, the Authorities wished boring to be carried on with to a depth of 150 feet, in the hope of

FIG: No 6
SECTION OF No 2 BORE-HOLE



striking a layer of marlstone, which was believed to exist below the Upper Lias Stratum (Fig. 3).

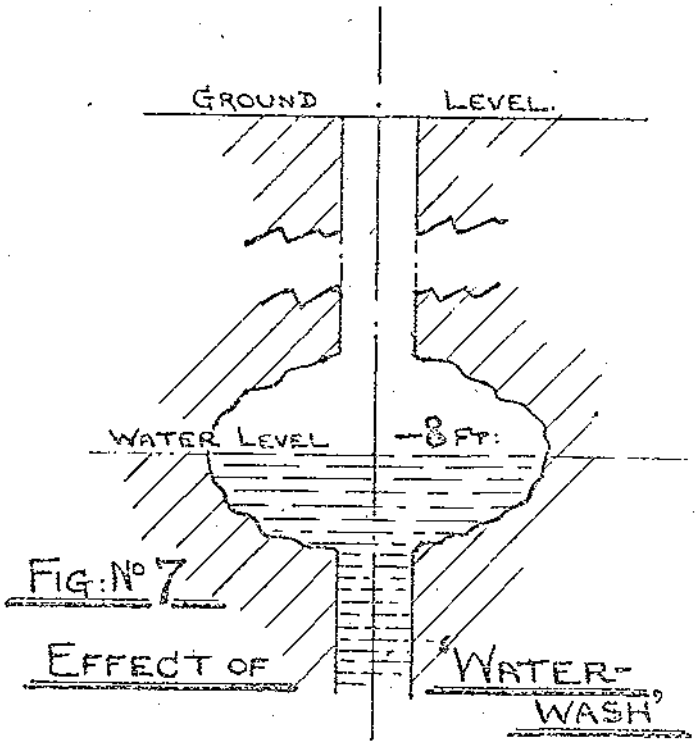


FIG: N° 7

EFFECT OF 'WATER-WASH'

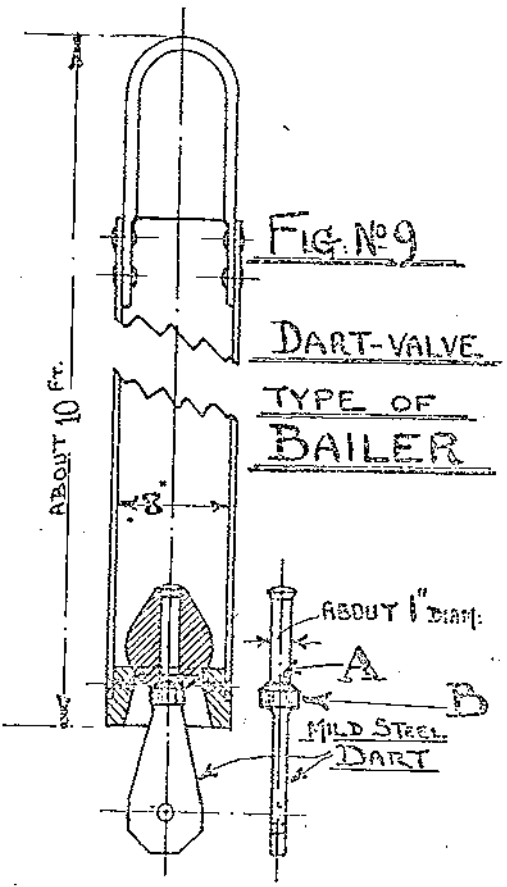
On February 9th, at a depth of 112 feet, a mishap occurred which ultimately caused the abandonment of this (No. 2) hole on February 13th.

Bailing-out had been accomplished all through by means of an 8 in. Dart-Valve bailer, shown in Fig. 9. Normally, when the bailer reaches the bottom of the bore-hole (lowered by means of the sand line) the 'Dart' secured to the 'Ball' of the valve raises the latter off the valve seat, allowing the borings, mixed with water, to enter the bailer body. It was the fracture of the dart stem at the point A which allowed the dart to fall off and remain at the bottom of the bore.

The fishing tools which had been brought up from Chatham were tried and found to be unsuitable to get a grip of such an awkwardly shaped piece, and authority was obtained to hire a set of rods and fishing tools from a firm of Well-boring Engineers at a neighbouring town. This firm was most helpful in the advice offered and in sending out at once the most suitable fishing tools it had in stock.

The tool recommended and lent by the firm was a "Crowsfoot" (see Fig. 10) which is lowered down the bore-hole (by means of the sand line) at the end of successive lengths—each about 10ft. long—of square steel rod, each length screwed into the next. When the foot of the crowsfoot reaches the bottom of the bore, the rods are

given a twisting motion by hand, and with continual trial, and the help of good luck, a grip is sometimes obtained by the crowsfoot hook of the obstruction. When it is thought that this has been brought about, the rods are raised and unscrewed until the crowsfoot reaches the surface.



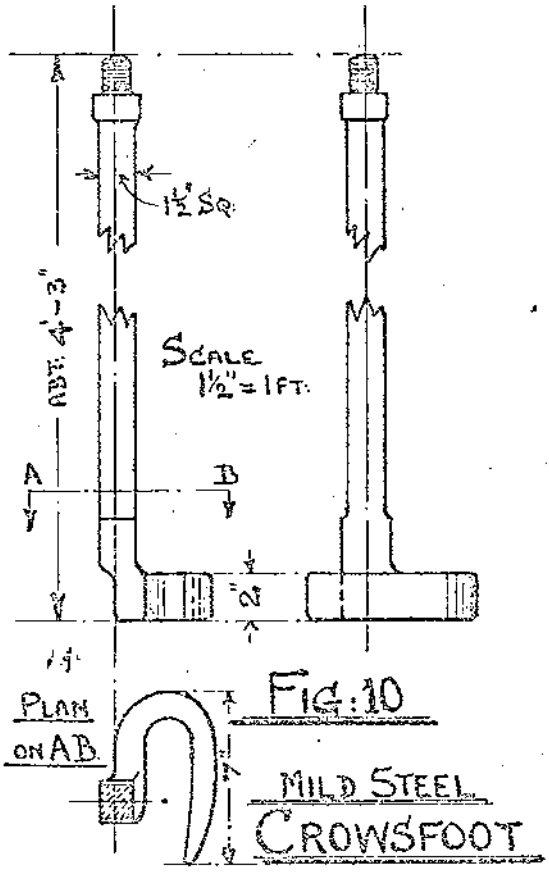
The chances, in this case, of being able to get a grip of the "dart" were not too good, as it was thought possible that the dart had become pushed into the sides of the bore by blows from the bailer before the loss was discovered. However, trial was made for two days, when orders were received to abandon the hole and commence drilling at bore-hole No. 3 (Fig. 1).

It may be mentioned here that it was thought advisable not to attempt to drill past the obstructing dart, as the latter was just a little too large to give this method hope of success, and even if the dart had been beaten into the sides of the bore, it might:

(a) have caused the bore to deviate from the true vertical;

(b) Possibly have dropped down later on and jammed the whole string of tools.

The actual progress in the drilling of this No. 2 hole was not remarkable for speed—an average of approximately 1 foot per hour of actual drilling time—as it is well known that far greater



rates of drilling have been accomplished when boring in certain strata such as chalk. However, certain factors militated against sinking this bore quickly, among which are the following :—

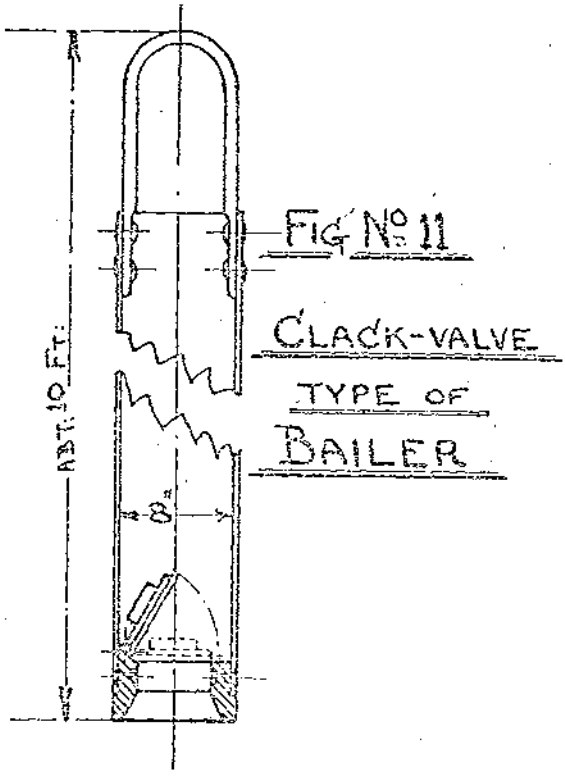
(i) the cheese-like, sticky consistency of the blue clay, which latter adhered to the lower 18ins. of the drilling bit ; and the reluctance of this clay to mix well with water, thus making bailing also difficult.

(ii) The fracture of the cable drum brake band, due to wear and tear, the "Keystone" being an old machine—and necessary repairs.

(iii) Slipping of the main belt drive, due to (a) exposure to snow and rain, (b) the drilling bit being inclined to stick in the clay after the downward stroke.

(iv) Unsuitability of the "Dart-Valve" type of bailer, a "Clack-Valve" type, (Fig. 11) which was obtained during the

drilling of No. 3 hole, being much more suitable for dealing with the clay bailings.



The actual number of drilling hours in connection with this (No. 2) hole was 120 ; this gives a drilling rate of .93 feet per hour.

It has been already mentioned that the small supply of water, which had been struck at a depth of 15 feet, had to be shut out by casing. As a result of this, all water required for : (a) the steam boiler supplying an 8 h.p. vertical engine embodied in the "Keystone rig, (b) actual drilling purposes at the bottom of the bore—had to be carted to the site by local contractor from Y village. The water for drilling had to be pumped into the bore from a small tank by L. & F. Pump : about 20 gallons per foot drilled was found necessary.

The approximate total amount of water used in drilling this hole, for purposes (a) and (b) above, was 9,000 gallons. This is an amount of 280 gallons per steaming day of 9 hours.

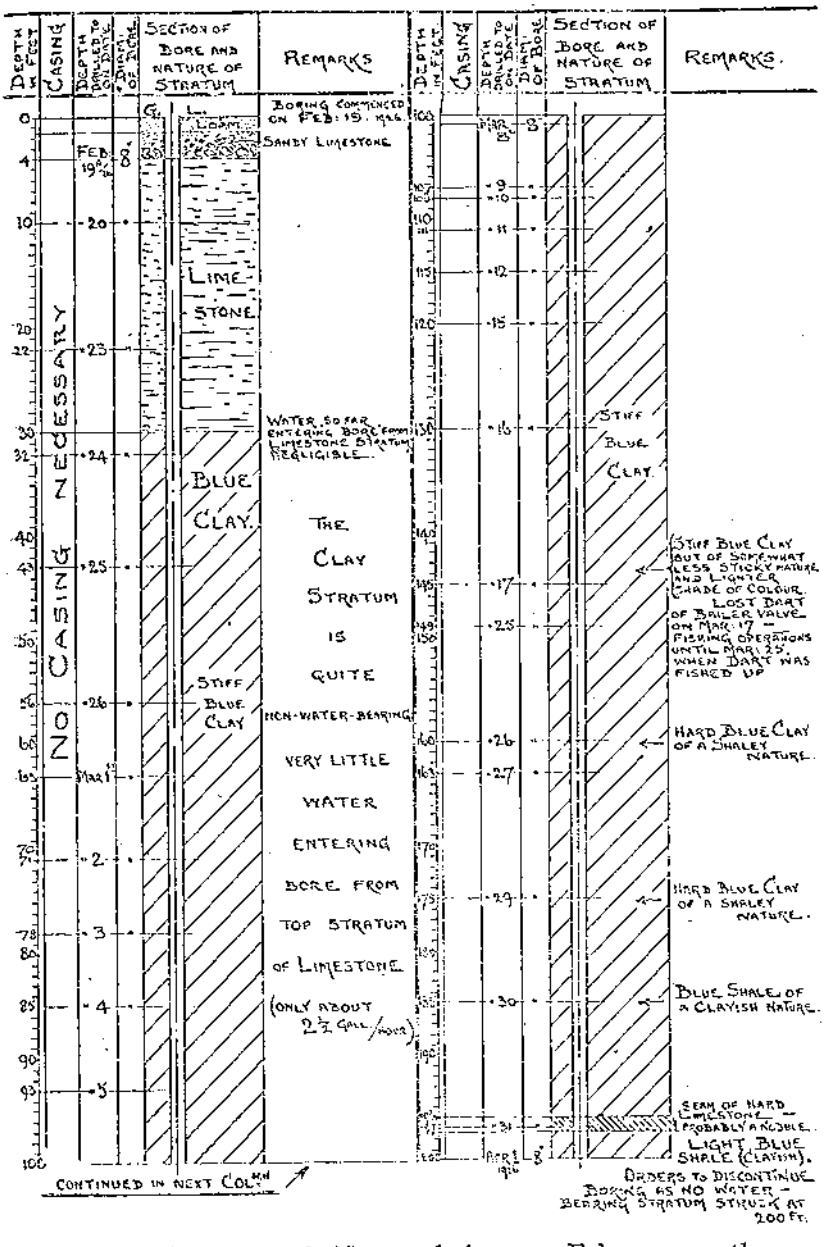
As regards the consumption of coal on this (No. 2) hole, an average of 475 lbs. per steaming day of 9 hours was used. This average covered getting the "Keystone" to the site, setting up, actual drilling hours, and time when actual drilling could not be proceeded with, and dismantling.

Coal was delivered at the site by the contractor supplying coal to the local R.A.S.C. representative.

No. 3 Bore-Hole.

A glance at Fig. No. 8 will show the main features of this No. 3 Bore-hole.

Fig. No. 8
SECTION OF No. 3 BORE-HOLE



The abandonment of No. 2 hole on February 13th was followed by the necessary lifting out of the 38 feet of casing from

the abandoned hole, the lowering of the derrick, and by the other preparations necessary to move the "Keystone," under its own steam, to the site of No. 3 hole, a distance of about 400 yards away.

The heavy "Keystone" travelled over the soft stubble tolerably well, and reached its new position by the evening of the 17th February. The derrick was raised and the machine set up and made ready to drill by noon on February 19th.

Boring commenced and was carried down, again using an 8in. rock bit, through the top 4 feet of loam and loose pieces of limestone, into fairly solid limestone rock. This last-named, however, yielded only a very small supply of water—almost negligible, about $2\frac{1}{2}$ gallons per hour—and the drill, at depth 30 feet, pierced through this stone stratum and again entered the blue clay.

This was a distinct disappointment, as the limestone was regarded as being the stratum most likely to provide a reasonable supply of water, it being in this case about 30 feet thick, as against only 20 feet in No. 2 hole.

Soon after the commencement of this hole the 8 in. dart-valve bailer was received back repaired, having had a new dart rivetted into the ball of the valve at the base of the bailer (Fig. 9).

Drilling continued successfully in the blue clay, but in vain as regards the striking of a water-bearing stratum. At an approximate depth of 80 ft. and for some distance, difficulty was experienced in getting the plastic, cheese-like clay at the bottom of the bore to enter the bailer (dart-valve variety), which, for this class of stratum is the wrong type, a bailer fitted with a clack-valve (Fig. 11) being much more suitable.

A bailer of this latter description was received in due course and proved to be much more effective.

A depth of 145 feet had been reached on March, 17th, using the same drilling bit (8in. rock drill) and the 8in. dart-valve bailer, which latter, since it had been repaired and fitted with new dart, had been in constant and hard use.

At this point a serious mishap again occurred: the dart of the bailer again broke off at the root of the shank and remained at the bottom of the hole. This was specially unfortunate as the stratum had been improving for the last three days, and had now become, although still clay, considerably less sticky and cheese-like and a lighter colour; also progress had been increasing very considerably in the daily depth drilled. These considerations had raised some hopes that the bore might be nearing a fresh stratum beneath the blue clay.

Authority was obtained to hire again locally the necessary fishing tools and rods, etc., and to make an attempt to raise the obstruction from the bottom of the hole, at a depth of 145 feet.

A crowsfoot (Fig. 10), sufficient length of 2in. square steel rods and

the necessary accessories were obtained with as little delay as possible by motor lorry, and fishing for the lost dart commenced on March 22nd. A certain amount of sediment had to be removed from the bore before any contact of the crowsfoot with the obstruction could be detected. The chances of being able to "hook" the dart were not too unlikely, as it was considered very probable that the dart must be in a fairly upright position, with the collar B (Fig. 9) uppermost.

After a good deal of ineffective trial, success was met with on March 25th, when the claw of the crowsfoot eventually was persuaded to embrace the obstructing dart at a point just under the collar B, (Fig. 9) and the dart was withdrawn from the hole.

Drilling thereupon recommenced, it having been decided that the bore should be sunk to a depth of 200 feet. Steady progress was now made, the clay stratum becoming slowly of a harder nature, until at a depth of 185 feet the clay became almost a soft shale. At depth 200 feet the stratum was a shaley clay of a light blueish-grey colour—still, however, non-waterbearing. Here drilling was discontinued.

The water entering the bore at depth 200 feet was almost negligible in amount (about 2½ gallons per hour), and this quantity issued from the limestone cap. This being the case, all water for drilling purposes, and also for steaming, had to be carted to the site by local contractor.

The amount of water required for boring purposes only was approximately the same as that found necessary in No. 2 hole, i.e., 20 gallons per foot drilled.

The amount of water used in this (No 3) hole for both boring and for the boiler was approximately 390 gallons per steaming day of 9 hours.

Regarding the coal consumption, it was found that a quantity of approximately 750 lbs. per steaming day of 9 hours was used. This is somewhat higher than the corresponding coal consumption on No. 2 hole, due largely to the fact that a much cheaper, and therefore an inferior, class of coal was being supplied.

This (No. 3) hole was bored at the rate of 1.19 foot per hour of actual drilling time—a slightly better rate than that in the case of No. 2 hole, which was .93 foot per hour.

It was found that no casing was necessary in drilling this hole.

Having drilled to a depth of 200ft. with no success, orders were now received to dismantle, pack up and return to Chatham.

The "Keystone" propelled itself successfully across the 1,000 yards of stubble area, the latter being naturally much dryer and firmer than in January. The journey from the camp site to Town Z goods yard was carried out successfully, the 3-ton lorry which performed the towing being used as an auxiliary brake in descending the long

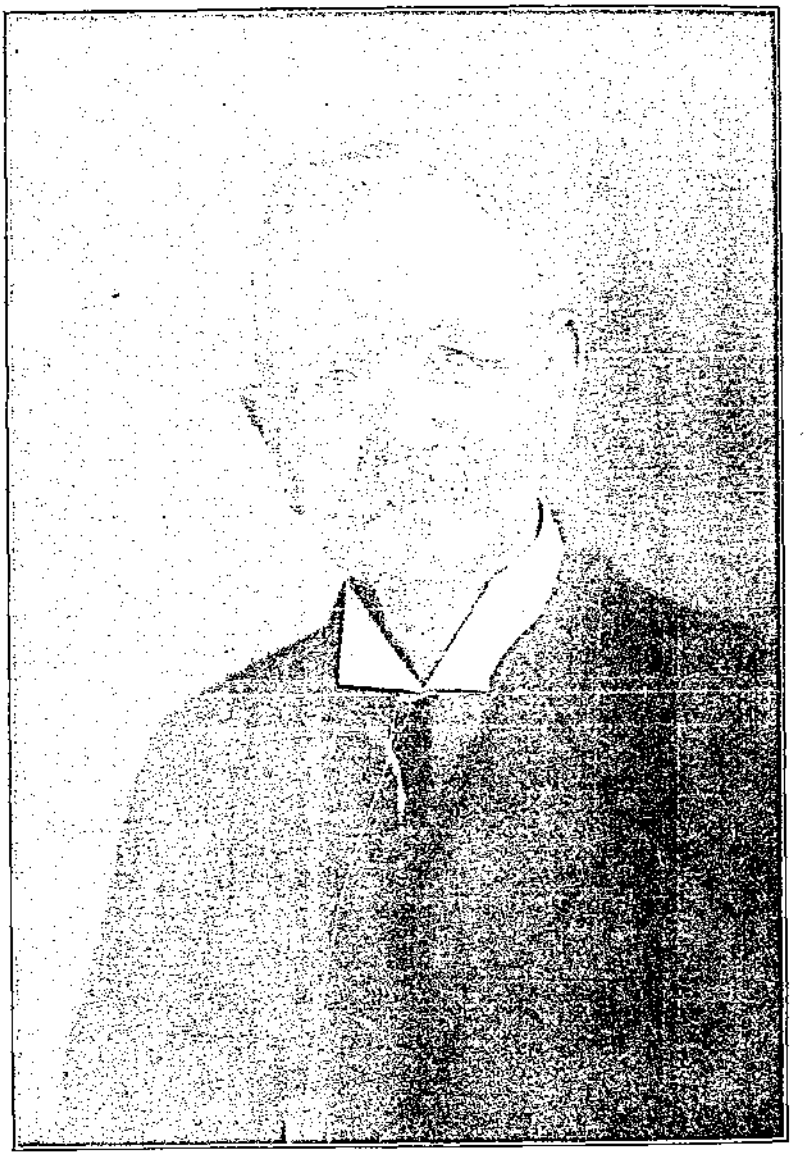
steep hill into Town Z. The "Keystone" was loaded on to a special railway wagon by means of a 10-ton jib crane on April 8th, and all other tools and accessories were put on to rail at the local railway station.

Samples of the strata from both bore-holes were taken at every 5 feet depth and at each change of stratum. These samples were selected, often from the actual bailings, but usually from stratum adhering to the point of the drill.

Samples, each about 50 cubic inches, were stored in long boxes of 10 compartments each, samples being carefully labelled.

CONCLUSION.

The information obtained from the two trial holes gave ample evidence that sufficient water could not be obtained from below ground on the Camp site. Arrangements were thereupon completed with the Town Z Corporation Water Works to supply the necessary amount of water. To make this possible, a 5in. water main was very soon laid along the main road (Town Z to Village Y) from a large reservoir at point Q (see Fig. 2) to the Camp site, a distance of about 2½ miles.



General Sir Charles Warren, G.C.M.G., K.C.B., F.R.S.
Colonel Commandant R.E.

Photograph by Messrs. Elliott & Fry, Ltd.,
63, Baker Street, W.1.

MEMOIR.

GENERAL SIR CHARLES WARREN, G.C.M.G., K.C.B., F.R.S.

General Sir Charles Warren, G.C.M.G., K.C.B., F.R.S., Col. Commandant Royal Engineers, Knight of Justice of the Order of St. John of Jerusalem, was born at Bangor, North Wales, on 7th February, 1840.

He was the second son of the late Major-General Sir Charles Warren, K.C.B., Colonel of the 96th Regiment (now 2nd Battalion The Manchester Regiment), a distinguished officer who had commanded a Brigade in the Crimean Campaign.

Sir Charles, the subject of this memoir, was educated at Bridgnorth Town Grammar School, Cheltenham College, R.M.C. Sandhurst, and R.M.A. Woolwich, and entered the Royal Engineers as Lieutenant on 23rd December, 1857.

Some comment is called for regarding the circumstance of a Royal Engineer officer commencing his military career at the R.M.C.

This was in the days of nomination, before competitive examinations for cadetships had been introduced. The patron of the prospective cadet wrote to the Commander-in-Chief, who, if satisfied, gave the nomination. Those nominated presented themselves for examination both in knowledge and medical fitness, and all passed. It is possible an utter failure would have been spun, but such a case was rare.

When Warren joined the R.M.A. it is recorded that he applied for the privileges of an Old Cadet, an exalted position giving freedom of the library and other privileges only granted after 12 months probation, and the application met with success, from which it is inferred that he must have been some 12 months at the R.M.C.

Now the Crimean War ended in November, 1855, and the R.E. came out of the siege of Sebastopol with flying colours. It may have been that Warren's father thought it would be good for his son to get transferred to the R.M.A. There is little doubt that there was a boom in R.E., for no less than 45 commissions were given in 1857.

Warren's course at the R.E. establishment, Chatham, was brief, according to our ideas, for the whole term, including leave, expired on 2nd January, 1859, when he proceeded to Gibraltar, and was

there occupied on Survey of the Rock till 29th July, 1865. During this period, in company with another Subaltern R.E., and two other officers of the garrison, he proceeded to climb from the back up to the top of the Rock. The incentive to this expedition appears to have been that the feat was popularly supposed to be impossible. So, naturally they did it without any aids but what nature provided.

Another diversion was a walking tour in company with the same R.E. Subaltern, carrying their kits on their backs, and ending with a 40-mile march back to Gibraltar from Alcada de la Frontera. Needless to say, this was before the days of organized amusements, such as every garrison now possesses, and by the way be it remarked that the writer of this memoir remembers Colonel Warren, as he knew him, had no use for cricket, and was enthusiastic about boating of all kinds.

On return from Gibraltar, after some weeks' leave, he took up the post of Assistant Instructor in Survey at Chatham. This lasted till 31st January, 1867, when he was selected for special employment in connection with excavations at Jerusalem, and reconnaissance of Palestine for the Palestine Exploration Fund. Some account of this work is to be found in the *History of The Corps of R.E., Vol. II*, and in a short article by Sir Charles Warren, himself, on *The Diamond Jubilee of the Palestine Exploration Fund*, of which the following is a very brief summary :—

The basis of the movement was the accurate Ordnance Survey of Jerusalem (and its water sources) at present in use, carried out by Captain C. W. Wilson, R.E., in 1864-5, from funds supplied by Miss Burdett Coutts.

Then followed a rapid examination of all Palestine, which led to the conclusion that the most interesting site in the Holy Land for exploration was Jerusalem itself.

To this Warren devoted himself for three years until forced to give up by malaria, contracted from working in the subsoil of the city.

In relinquishing the work he called attention to the pressing necessity for an accurate Topographical Survey of the Holy Land, because treasures underground would keep safely for years, whereas those above ground were rapidly disappearing owing to the inexorable demands of the march of civilization.

The *History of the Corps* makes mention of shortage of funds, and amongst other S.O.S. messages was one to the effect : " For Heaven's sake find the tomb of David or we shall be bankrupt."

Warren replies, "If I do find the Tomb of David I shall certainly seal it up again ; such good things are not for the like of us." He further adds : " I firmly believe George Grove had an uneasy notion that I had struck the Tomb, and on account of my views on the desecration of tombs would not give it out to the public."

But Warren looked upon controversy as the chief means of obtaining subscribers to the Fund, and hazarded the guess that theories and speculations brought in, at least, £1,000 a year to the P.E.F.

He adds: "I sincerely trust that what I have said in this paper will not be agreed to by all, but that it will arouse the antagonism of many who may think my observations worth powder and shot. As for myself, I am ready to fight on any of the theories I uphold, but how can we enjoy shooting if one's antagonists lie low or hold up their hands?"

He dearly loved a fight even in his eighty-eighth year! He offered a donation of £100 for excavations on the Hill of Ophel, south of the Haram Esh-Sherif, provided forty-nine other persons should subscribe £100 each..

We next find him at Shoeburyness, where he spent nearly 5 years, being ordered on duty to South Africa as special commissioner, in conjunction with a colleague nominated by the Orange Free State, to delimitate the boundary between that State and Griqualand West. This he completed by May, 1877, and was rewarded by Her Majesty Queen Victoria with the *C.M.G.*

Returning homewards in June, he walked from the goldfields in the neighbourhood of what is now known as Johannesburg to Delagoa Bay, reconnoitring the route for a railway then projected. On reaching the coast, Warren found a telegram requesting his return to Griqualand West as Special Commissioner to investigate disputed land claims.

In January, 1878, the Kaffir War broke out, and Captain Warren was appointed to command the Diamond Fields Horse, with local rank of Lieut.-Colonel. Marching the 500 miles from the Diamond Fields to Kaffraria he was engaged in several fights, culminating in the relief of Colonel Owen Lanyon, who was held up on the Orange River.

He was several times mentioned in despatches, and received the brevet rank of Lieut.-Colonel 11th November, 1878, as reward for his services. The Colonial Office indeed made a strong claim for reward of higher rank, but this was ignored.

A brief week's leave intervened when he took up the post of Instructor in Survey at the S.M.E. (now called Chief Instructor). This was interrupted by his despatch to Egypt on 24th August, 1882, to lead a search expedition in the Arabian Desert to discover the fate of the members of the special mission under the leadership of Professor E. Palmer, which had set out from Suez on 8th August, 1882, and disappeared, apparently, without trace. This episode calls for a more lengthy comment than is usual in a memoir of this nature, owing to the unusual circumstances of an expedition into an unsettled and partially hostile country unaccompanied by civilized troops, and relying for safeguard on a miscellaneous collection of members of various Arab tribes, comprising fellow tribesmen and

even relatives of the men suspected to be implicated in the disappearance of the missing Europeans and their attendants.

Professor Edward Henry Palmer, Fellow of St. John's College, Cambridge, Lord Almoner's Professor of Arabic, was a well-known traveller and eminent scholar of his time, who seems to have had a special aptitude for entering into sympathetic understanding with the Arabs of the Desert, and travelled amongst them without any misgivings as to their fanaticism and treachery towards an unbeliever.

He set out from Jaffa on July 9th and proceeded to Gaza by land. Leaving on July 15th to visit the Bedouin of the Desert of Tih, he arrived at Suez on August 1st, where he got on board a British man-of-war.

These were the times of the "Arabi rebellion" in Egypt, and Suez itself was in the hands of the rebels. On August 6th, Capt. W. J. Gill, R.E., met Prof. Palmer, and together they concerted measures for re-entering the desert from Suez. On August 8th they started, the party being composed of Prof. Palmer, Captain Gill, R.E., Lieut. Harold Charrington, R.N., Khalil Atek (a Syrian Christian), a Jew cook, Bokhor, and two Bedouin, Metter Sofia and his nephew, Salami-Ibn-Aid, besides camel men. At the outbreak of the rebellion Colonel Warren submitted a memorandum to Government to show what use could be made of the Bedouin, being then unaware that Palmer was already engaged in the desert to report on the same subject. By a coincidence, Warren signed the report about midnight, August 10th, the very day, as subsequently transpired, when Palmer's party met their fate.

In this memorandum Warren deprecated the employment of British troops among the Bedouin and proposed to trust entirely to the tribesmen, provided the leader of the party were accompanied by two or more assistants, so that one could always be awake and watch during the night, when treachery was most to be feared.

On August 24th, he was summoned to the Admiralty and directed to report to Admiral Sir Beauchamp Seymour, accompanied by Lieuts. E. M. Burton and A. E. Haynes R.E. (the companions he selected), for such duty as might be required of him in the desert. He proceeded next day with Lieut. Haynes and was followed by Lieut. Burton from Ireland.

He found Sir Beauchamp Seymour at Ismailia, and was given the immediate mission of ascertaining the fate of Palmer and his party.

At that time the Suez Canal was under control of the Admiralty, and that waterway and the country to the east remained under that jurisdiction till final settlement after the campaign had come to a close. Moving on to Suez, he reported to Admiral Sir W. Hewett, V.C., who provided H.M.S. "Cockatrice" to carry the party and a

present of grain for the monks of Sinai to Tor, the port of Sinai Peninsula.

The Moslems of Egypt and Arabia were in a ferment. A *Jihad* had been proclaimed in Syria as well as in Egypt. The emissaries of Arabi had been among the Bedouin, who were led to believe Arabi to be the Prophet Isa come to raise the Moslems to dominant power. There had been massacres of Christians, and the tribes round Sinai were being urged to sack Tor and the convent at Sinai, and to murder all Christians.

The influence of the local Sheikh, Musa Nusier, served to restrain the hot-heads, and Warren and his party, though camped in the open outside the town, and effectively surrounded, were saved from molestation. It is believed that the unexpected appearance of an exceptionally brilliant comet, much commented on at the time and even alleged to be the Star of Bethlehem, had some effect on the superstitions of the Bedouin and Egyptian Arabs.

The sheikh did not, however, come in, and camels were not to be had, so Warren and his party returned to Suez.

On September 25th, Arabi had been defeated, and Cairo occupied, but as rumours had been circulated in the Arabian desert that the British army had been defeated and pursued back to Ismailia, penetration of the country was out of the question till the truth, should filter through. So Colonel Warren made preparations for entering the desert escorted by a contingent of Nile Bedouin allied to their corresponding tribes of Arabia, and a party of 20 from each of certain tribes were to be mustered at Cairo by the Shedid (head Sheikh of the Nile Bedouin), to the number of 160.

The existence of blood feuds between certain of these tribes accentuated the difficulty of mustering suitable men, so some of the Sheikhs were left in custody until the expedition should return in safety, and representatives of the Shedid were made to accompany the party.

While this business was in progress under Lieut. Burton, Col. Warren went to Akabah in H.M.S. "Eclipse."

Arriving on October 10th, he encountered hostility on the part of the Governor and his garrison, and there was some delicate parleying till the Governor could be persuaded that the reign of Arabi was at an end, and that he must hoist the Khedive's flag or stand the consequences.

From the Governor of Akabah the Colonel contrived to secure a letter from the Governor of Nackl which announced that Palmer and his party had been killed. This done, he returned to Suez by October 14th.

On the 19th, Musa Nusier, Sheikh of the Towara, arrived from Tor, and undertook to safeguard Col. Warren and his party, consisting of Lieuts. Burton and Haynes, and 2 Syrian interpreters, 370 men

and 200 camels, also the new Governor who was being escorted to Nackl to replace the Arabist Governor. The caravan was also carrying grain for the annual Haj Pilgrims, and the year's rations for the soldiers of the Fort.

On the way some of Palmer's camel men were picked up, also some prisoners, and from their evidence Col. Warren was able to locate and visit the place where the remains of Palmer and his companions were collected; these were eventually conveyed to England for interment in the Crypt of St. Paul's Cathedral.

This done, Warren pushed on to Nackl, where the Governor, who dominated the water supply, proved troublesome. But Warren dominated the rations, which were much overdue; ousted the Governor, installed the new one and proceeded on his way to further enquiries in direction of Gatié, about 150 miles. This proved abortive. Haynes had to be sent back to Ismailia suffering from sunstroke. Metter Sofia, the object of this further search, now came in and surrendered, bringing with him one of the 3 bags of 1,000 sovereigns carried by Palmer. Colonel Warren now dismissed the Nile Bedouin and sent for Salami Shedid, who was placed at his disposal by the Government.

This important sheikh, after a show of much obstruction, was despatched to round up the remaining men implicated in or witnesses of the murder, of whom Warren had a list, extracted by careful and painstaking cross-questioning of numerous witnesses roped in in the course of his journeys. By December 25th many of these had been collected.

Their trial was duly arranged, with Lieut. Burton as prosecutor, Warren watching the case on behalf of the British Government, and while waiting result of the trial, he proceeded in H.M.S. "Decoy" from Alexandria, on February 23rd, 1883, and landed at El Arish on 25th. His object was to search for more criminals in the fastnesses of Jebel Hilall. This project he had in the end to abandon, but incidentally he found out certain malpractices on the part of the Governor of El Arish, then absent, who had installed his son as acting governor in despite of Government orders to the contrary.

Warren found all this out, deposed the acting governor, installed the proper substitute, an officer of the garrison, on his own initiative, and reported by telegraph to Cairo what he had done. The offending Governor was removed.

While at El Arish, Warren received news that the five men condemned by court-martial for murder of Palmer's party had been executed. Other individuals implicated received various terms of imprisonment, headed by 15 years for the nephew of Metter Sofia, who was proved to have made off with the £3,000 entrusted to him, of which £1,000 had been recovered, and the property of the Sofia family was confiscated to the State to make good the remainder.

Warren and his party returned overland from El Arish to El Kantara against a strong Khamsin wind, and had a very trying time. After a visit to Cairo, the party returned to England in March, 1883.

The success of the work owed much to the cordial co-operation of all ranks of the British Navy. Colonel Warren established a remarkable ascendancy over the Bedouin by his rigid straightforwardness and perfect rectitude of conduct.

The execution of punishment, which was admitted to be just, roused no general feeling of resentment in the tribes, and this is corroborated by the testimony of Kitchener.

An interesting account of the expedition was published by Captain Haynes in 1894, under the title "Man-Hunting in the Desert."

Warren returned to Chatham to resume his old position of head of the Survey School till 11th November, 1884, when he was appointed to be Her Majesty's Commissioner for Bechuanaland. The Boers had been quietly appropriating this country. Warren, with a well-equipped little army, partly regulars, but mostly picked volunteers, had again orders to clear the country. These orders were promptly and brilliantly executed.

Before long Warren had established his column at Mafeking, 314 miles beyond railhead. The campaign was a bloodless one, and the troops were withdrawn in July and August, having accomplished all that the Government deemed advisable, with the establishment of British Bechuanaland as a Crown Colony.

After a short period of leave, we again find Warren back in Egypt and the Egyptian Soudan, where for nearly two months he was appointed local Major-General on the staff to command Suakim.

It will thus be observed that Warren was employed in Egypt and the Soudan on two separate occasions, and his record of service credits him with the campaign, Egyptian Expedition, 1882, and special service in connection with the murder of Prof. Palmer and his party. For these services he received the Egyptian Medal, Khedive's Bronze Star, K.C.M.G., and Order of the Medjidie 3rd Class. For his services in Bechuanaland he received the G.C.M.G.

Haled back to England, he was appointed on 29th March, 1886, to succeed his brother officer, Sir Edmund Henderson, as Chief Commissioner, Metropolitan Police. During his tenure of this difficult position occurred the Jubilee of Her Majesty Queen Victoria's reign, and the arrangements for keeping order during the festivities called for special measures of vigilance that were suitably recognized, not only by a letter from the Secretary of State (Henry Matthews), conveying, by the Queen's express commands, her sense of approbation, but also by the decoration of K.C.B. conferred by Her Majesty.

The work was strenuous, and much had still to be done to round off the improvements introduced by Sir Edmund Henderson during his sixteen years' tenure of the appointment.

It may be remembered that 1888 was marked by the mysterious "Whitechapel murders," attributed to a nebulous person known in the "East End" under the sobriquet of "Jack the Ripper," who eluded the vigilance of the police.

But this had nothing to do with Warren's resignation of his appointment on 8th November, 1888. which arose from other causes in no way connected with the failure of the police to track the miscreant.

The curious will find the matter threshed out in the Parliamentary debates of the period published in "The Times," 14th and 15th November, 1888. Mr. Matthews paid a tribute to Sir C. Warren, in his last speech on the subject, describing him as "not only of highest character, but of great ability . . . . By vigour and firmness he had restored that confidence in the Police which had been shaken (and unjustly shaken) by the unfortunate incident of 1886."

In this connection it is worth mentioning that a brother officer whose duty lay in London for a considerable period about this time, and subsequently, writes, "Constantly in London after Warren's resignation of the Chief Commissionership his subordinates told me, 'He was the best Commissioner they ever had.'"

Warren was still only a Regimental Lieut.-Col., though he had been Colonel by Brevet since 11th November, 1882, so employment was found for him at Dover till 3rd April, 1889, when he was appointed Colonel on Staff Commanding Troops at Singapore.

This command had just been lopped off from Hong-Kong and conferred on Sir Charles Warren the rank of substantive Colonel as from 4th April, 1889, and this he retained for nearly four years, in the course of which he received his decoration of G.C.M.G., which, with the K.C.B. he already held, established a record only once previously attained by a Colonel.

The defences had been constructed under direction of the Colonial Government by Lieut.-Col. Sir H. E. McCallum, K.C.M.G., R.E., Colonial Engineer, Straits Settlements, and had yet to be armed and provided with minor accessories, such as temporary barracks for the gunners for manning on mobilization.

Command and inter-communication lines did not exist and had to be provided.

Sir Charles even attempted a wireless communication between the two forts commanding the western entrance to the Straits, and thus foresaw in 1892 what was to be the outcome of the researches of Edison, and of an unexplainable conversation that had been carried on between an engine-room and a test-room in the Singapore defences that were not connected by any circuit.

This last-mentioned circumstance was duly reported to experts in England, but it remained a mystery to be elucidated in after years, when wireless communication had been developed in a more advanced form by Marconi.

There was much to be done in other ways. The stereotyped Infantry training at that time in force did not appeal to Sir Charles. He ran a tilt against the "Adjutant's Battalion" of those times, insisted on Company training, abolished the two daily parades, and started practical work in the field.

There was no Defence Scheme, no *Mobilization Regulations.*

With characteristic energy, in spite of an exhausting climate, Sir Charles set himself to fill the gap, and even anticipated developments that became subjects of regulation after the South African War, which was yet to come.

These mobilization regulations formed the basis of those put into practice in 1914, with some minor alterations of detail conforming to more modern conditions, and were found to work with astounding smoothness.

It was not till 1st April, 1893, that Sir Charles was promoted to Major-General on the Staff, and he still retained his command for rather more than a year.

Sir Charles was not accompanied by his family when in the Straits Settlements, and when his time came for leave he devoted it to an extensive tour of some 10,000 miles in India, beginning at Negapatam on the S.E. coast, and going as far as Quetta and Peshawur before returning *via* Calcutta and Burma. Later on, he visited Japan.

Viewed in the light of after years, the period of Sir Charles Warren's five years' command at Singapore was one of achievement and progress.

This was really his first peace command, and he brought to bear on it the accumulated experience of a varied career in command of men of various characteristics and nationalities, and a thoroughly practical knowledge of the actual mechanism of war.

His leading characteristic as a leader was driving force, coupled with a gift of imparting knowledge for which, no doubt, he was indebted to his practice as an instructor at the S.M.E. Add to this a marvellously retentive memory and a capacity for storing up and remembering details of administration, and you have a commander thoroughly versed in the petty, as well as the great, problems involved in a recently developed sphere of activity. The welfare of the soldier was not the least of his cares, and in this he brought to bear the sympathetic and kindly side of his nature; and woe to the subordinate commander who neglected, by lack of energy or by inadvertence, to administer to the wants of those under his charge in a trying and enervating climate.

With all this push and seeming severity those who served under

him at that time look back with reverence to the man who taught them how to think in the military sense, and when off duty was a charming companion, *bon raconteur*, and a thoroughly good fellow.

After a period of unemployment of little more than a year he assumed command of the Thames and Medway District, with H.Q. at Chatham.

This was hardly an employment that gave full scope to a man of active temperament, accustomed to more stirring scenes, the ordinary routine work being only diversified by skeleton manning schemes and a brief spell of Army manœuvres. Nevertheless, he left on record a complete set of defence schemes conceived in the spirit of the then existing school of thought and worked out with some elaboration of detail.

The event proved that these manning schemes became very useful for the training of all available 2nd and 3rd line troops, which were called out during the fine summer weather of 1900.

Warren completed his term of service at Chatham on 30th Sept., 1898, and again had a period of unemployment for some thirteen months, when he was selected to command the Fifth Division South African Field Force, under Sir Redvers Buller as C.-in-C.

He served throughout the operations culminating in the Relief of Ladysmith, and he was then transferred to the position of Military Administrator of Griqualand West, and his active service came to a close on 24th August, 1900.

Warren became the victim of some adverse comment in his conduct of the military operations entrusted to him, especially those connected with the attack on Spion Kop. The paper contest was long, and carried on with vigour from both sides, *pro* and *con*.

That the failure was a setback is not to be denied; but there were several setbacks encountered in the campaign, and time pressed for the relief of Sir George White and his garrison.

Warren had now been a Lieut.-General since 1st October, 1897. He was promoted to General on 24th February, 1904, and Colonel-Commandant R.E. on 7th April, 1905. He was placed on retired pay on completion of five years' unemployment on 25th August, 1905.

But his retirement from military employ saw no abatement in his energy. He was an active member of several Masonic Lodges at home and abroad, and had been District Grand Master of the Eastern Archipelago under the English Constitution 1891-1895; he interested himself greatly in the Boy Scout movement, and spent much of his time training his youngsters and accompanying them in their outings.

His literary activities are evidenced by many publications and contributions to periodicals, the most noticeable of these being: Enlargement of General Frome's *Outlines of a Trigonometrical Survey*, 1873; *Underground Jerusalem*, 1874; *The Temple or the Tomb*,

1880; *On the Veldt in the Seventies*, 1902; *The Ancient Cubit and our Weights and Measures*, 1903; *The Early Weights and Measures of Mankind*, 1914; and other works.

Sir Charles Warren married, in 1864, Fanny Margaret, daughter of Samuel Haydon, of Guildford. She died in 1919. He himself met his end at a ripe old age at Weston-super-Mare, on 21st January, 1927.

He is survived by one son, in a different path of activity, and two daughters.

Such was Warren, who during his forty-seven years of service was much in the public eye, and was instrumental in reminding the world at large of the type of man the Corps of R.E. could produce when work of an exceptional nature in peace as well as in war had to be done.

In the account of our annual doings there appears a notice of the contest for the "Warren Shield" on the River Medway, and those who have served in Singapore may remember the competition on the rifle range for the "Warren Shield."

Who was Warren?

That the above inadequate sketch is an attempt to portray.

Thanks are due to many brother officers who have served with Sir Charles Warren for their contributions to and their co-operation in the compilation of this memoir.

J.A.F.

BRIGADIER-GENERAL COOPER PENROSE, C.B., C.M.G.

To a wide circle of friends, the death on the 12th of last April of Brigadier-General Cooper Penrose came as a great sorrow. To these friends he had endeared himself by a combination of qualities, not the least of which was a shy kind of modesty. Even to those fairly closely associated with his work at different periods, and with whom he was intimate, he spoke little or at all about past achievement or the varied services he had rendered to his country in different parts of the world. This reticence renders the task of the writer of this memoir a difficult one.

Cooper Penrose came of a branch of an ancient Cornish family, which had long been settled in Ireland. He was born in 1855, the third son of the late Rev. J. D. Penrose of Woodhill, County Cork. He was one of a large number of brothers and sisters, five boys and three girls. A very old friend writes, "My earliest recollection of Cooper, then nine years old, is of a boy with great power of concentration and a great love of reading. No matter what noisy games might be going on in the school room, he would sit on the ottoman in

Brigadier-General C. Penrose, C.B., C.M.G.

Photograph by Elliott & Fry, Ltd., 63, Baker Street, London, W.1.

front of the window altogether engrossed in his book. At that early age, he had already chosen his career. To the question "What are you going to be, Cooper?" the invariable answer came "I am going to be a Royal Engineer." No words of brothers or sisters could make him add "If I can."

In 1865, he was sent to a Preparatory School at Cheltenham, thence to Haileybury, from which School he passed direct into the Royal Military Academy, in 1872. Commissioned in September, 1875, he left the School of Military Engineering in 1876 for Glasgow, but returned thence in 1878 for a course in Submarine Mining, at that time a new service just being started on a considerable scale.

This service was destined to occupy much of Penrose's time and thoughts, and eventually he rose to be head of it. As a Submarine Miner he served at Camden Fort, Cork Harbour, then at Pembroke, then again at Cork, then off to Bermuda, and finally at the War Office, where, under Maj. General Sir R. M. Ruck, he was Assistant Inspector of Submarine Mining Defences from 1891 to 1896. He succeeded General Ruck as Inspector of Submarine Mining Defences on 1st January, 1897, and retained that appointment until the end of 1897.

During these years great advances were made in the organisation of the submarine mining service and in the speed at which considerable numbers of mines could be prepared and laid out. It also began to be realised that submarine warfare was likely to develop in several new directions. Penrose gave much thought to these and a number of preliminary trials, particularly as to the possibility of combining, for defence, mines with nets, were carried out under his superintendence.

The transfer of Submarine Mining Defences to the Navy terminated these investigations as far as the Army was concerned, but in the spring of 1915, Penrose submitted a number of suggestions based on these experiments, which, it is believed, proved to be of some help in meeting the great difficulties of that time, and for these he received the Admiralty's thanks.

During the earlier years of his service Penrose had, however, more than one break in his sequence of Submarine Mining duties. In June 1879, he was sent out to Natal with re-inforcements for the Zulu campaign. In 1882 he was employed in the removal of submerged rocks in the harbour of Holyhead. He had just finished this work when he was appointed Instructor in Military Topography at the Royal Military Academy, and he remained there two years.

In 1883, Penrose had the good fortune to become acquainted with Miss Sylvia Alice Greene, daughter of the late Thomas Greene of Dublin, who was destined in 1885 to become his constant companion and loving help-mate. The particulars of 42 years of ideal married life are outside the province of this chronicle, but the following brief extract from a letter written by a brother Officer may perhaps

be permitted "I met him several times when, as C.R.E. Gosport, he had that very nice C.R.E's quarters on the shore. I remember his three daughters, they were at that time growing fast and already very tall. He used to talk of them as "The Giants."

To return to 1885, shortly after his marriage, Penrose was sent out to New South Wales as one of four Imperial Officers appointed to act as instructors in military subjects, to the local Military Forces. That the efforts of this little band of Officers were not wasted has been amply proved by the record of the Australian contingents in the South African War of 1899-1902 and in the Great War 1914-1918.

In 1898 Penrose was ordered to Wei-Hai-Wei. The questions why that port and its surrounding territory were at that time taken over from the Japanese and why they were subsequently relinquished are now matters of ancient history. The presence of a British garrison was resented by the Chinese, and it is interesting to read from Penrose's private letters that he considered it would be unwise for Great Britain to retain the area permanently,—a view that was ultimately adopted by the British Government.

At Wei-Hai-Wei, Penrose found strenuous work of most varied kinds—survey, new barracks to build and all classes of engineer services to carry out, incidental to a new station devoid of any accommodation fit for Europeans.

In the Spring of 1900, a Survey for the purpose of delimiting the Anglo-Chinese boundary was put in hand.

The native population was sullen, but it was not thought that the progress of the survey would be actively opposed; however, things came to a head on 15th May, and Penrose's personal narrative of what then happened may be of interest, particularly to R.E. Officers now serving in China.

"We started on the 25th April, going that day to the western extremity of the boundary, where we camped. The following morning, after a pow-wow with the Chinese Commissioners, we started marking out the exact convention line, which was the only thing they would agree to. We got on well enough for two or three days, and had marked about 12-15 miles of the boundary out of forty, when we changed camp about twelve miles to the south east. The day after, which was a Sunday, we saw a large crowd passing the camp towards the village in which the Chinese Commissioners had taken up their abode. About two miles to the west, Colonel Bower had to get his men out to prevent the crowd from coming into the camp and keep them at a respectable distance.

These men were, so far as we could see, unarmed. We then wrote for re-inforcements and got another Company out of the Chinese Regiment, and in view of the large crowds assembled at the Chinese Headquarters, we wrote to the Chinese Commissioners that it was impossible to have the boundary marked in a satisfactory

manner if the people were hostile to it, and asking them for another conference on the subject. They came, after some demur, and we drew up proclamations, one for the Chinese and one for ourselves, dealing with their fears which were apparently quite illusionary with regard to increased taxation and such like. We then waited for a day or two so that the proclamations might be issued, and the people dispersed, and then we wrote and announced our intention of going on delineating the boundary. The Chinese Commissioners refused to come as the people were not quiet, so we started by ourselves with a strong escort, and did two days' work without them at all, and without any molestation, changing camp on the second day. As we had seen nobody on the last day I started out with only twelve men of the Chinese Regiment, and as luck would have it, instead of beginning where we had left the day before we began further down the line and worked backwards. When we had done about three miles Mr. Schaller, the Interpreter and Sec. of the Chinese Regiment, looking down into the valley, saw a large crowd of natives who were going towards our camp. With such a small party I thought it best to make for camp about two miles off, but I did not anticipate any trouble as the natives appeared to be unarmed. However, when we were about 500 yards from camp in a river bed—there were some trees about—I suddenly saw a whole lot of them within 20 yards armed with sticks and picking up stones to throw at us. The escort was halted and fixed bayonets, just in time to meet a rush of large crowds, who threw volleys of large stones and pushed back our men about 20 yards to a little hill, where they held their own with difficulty until the main body came up at the double at the sound of firing. I got off five shots with my revolver and killed one man with a bayonet who was, I think, the leader of the attack, before I was knocked over by a stone from behind. At the place where the attack first took place, and when on the ground, I was beaten with sticks while semi-conscious and prodded with bayonets. By some great mercy none of the stick or bayonet wounds were dangerous and after the enemy had been beaten off I was picked up and brought back to camp."

Though at the time Penrose made light of his wounds, they were no doubt more serious than probably he himself realised. It was a great disappointment to him that he did not recover from them in time to take part in the relief of Peking. The loss of the sight of one eye, which occurred some years later, was partly at least traceable to injuries received at this time, also indifferent health, bravely and patiently borne all through the later years of his life. A trip to Japan during the period of convalescence, accompanied by Mrs. Penrose, was a source of great interest. He was mentioned in despatches for his China Services and remained at Wei-Hai-Wei as C.R.E. until 1901, when he returned to England.

While C.R.E., Gosport, 1901-1905, Chief Engineer Portsmouth, 1906-1910, and Chief Engineer Southern Command, 1910-1912, Penrose had the opportunity of applying the principles governing Engineering work, particularly in relation to Coast Defences, which he had mastered in the course of his varied career in the junior ranks. That he did so successfully is vouched for, not only by official reports, but also by the warm appreciation conveyed to him personally by Officers under whom he served or who served under him, or who succeeded him in office. He was awarded the C.B. in 1910, and in 1912, on attaining the age of 57, retired with the rank of Brigadier-General.

In the outbreak of the Great War, Penrose was first re-employed on Ordnance Survey work at Clifton. In February, 1915, he was appointed C.E. Scottish Command and retained that office till August, 1916. After leaving Edinburgh he was employed as Inspector of Steel under the Admiralty, first at Sheffield, and then at Birmingham until the armistice. During Penrose's time in Scotland, the Northern part of the United Kingdom produced, in relation to its population, a very large number of men for training and despatch to the different fighting fronts. The small peace time staff as a rule maintained in the Scottish Command practically disappeared during the early months of the war. The C.E's tasks though very varied and numerous, were connected perhaps mainly with the housing of the large bodies of men who poured in from all parts of the country, and with their training, but there was also much to be done in connection with Defences, since raids on a large or small scale required to be provided against. Although he had a number of willing helpers, of whom the writer was one, they were not all very experienced and we often wondered how Penrose could find the physical and mental energy to carry through the work as he did. In recognition of his war service he received the C.M.G. in 1917.

Throughout his life Penrose was fond of games. He had a good eye, and was active of foot. He played racquets for the Corps 1876, and for a number of years was one of the best of our Lawn Tennis players. In this connection Major-General Sir Frederick Glubb, writing of Bermuda days, says "During 1881-1883 I constantly played tennis with Penrose and C.K. Wood, generally at the Grays. I remember he and I having a tremendous tussle in the Singles Championship finals once." He also went in a great deal for sailing. He was at Boaz as a Submarine Miner, and that was nearly equivalent to living on the water. He was a delightful man to play games with, as he was as keen as mustard, but never ruffled in the slightest, but able to rejoice in his opponents' good play as well as his own. At Bermuda he owned a small yacht named the *Psyche*. This little vessel, whose length was 16ft 10ins.,

carried a 33 ft. mast and a 27ft. boom. The navigation, and particularly the racing of a boat so heavily rigged, demanded considerable skill and was frequently not devoid of excitement, as the writer of this memoir, into whose possession the boat passed at a later date, can testify. This excitement Penrose enjoyed to the full. The following extract from a letter by Admiral Sir Ernest Gaunt, K.C.B., gives a characteristic picture of Cooper during his service in China. "For some two years when Commissioner at Wei-Hai-Wei, I was in close touch with Cooper Penrose. To deal with, both officially and as a mess mate, no one could wish for a more charming personality. We were rivals only in one branch, boat sailing. I had a 32-ft. Naval Service Galley, the R.E. a 27-ft. Whaler, both fitted with Chinese Lateen sails and manned with Chinese crews. Week after week we had sailing matches. Sometimes my boat was first, sometimes his. The excitement of the races stirred the crews as much as the Officers. We jockeyed for place, utilised all our knowledge of tides, and in the evenings fought our battles over again, great rivalry, but never rancour."

Penrose was fond of golf, and in later years became a very good croquet player. He was also a clever water-colour artist.

It is felt that the foregoing notes give an altogether inadequate picture of a man whose unselfishness, great courtesy, and many-sided charm, endeared him to all who had the privilege to know him. They may, perhaps, best be closed in the words of one of his friends, a distinguished officer of the Corps, who says "I do want to put on record my affection for him, my admiration for his character. Everybody who knew him loved and respected him. He was so unselfish and kind and lovable. Very loyal to his friends, and always the same, even after the lapse of years. Absolutely straight and trustworthy, and as I found out by succeeding him in office, a very thorough and careful worker, and full of common sense and consideration for other people's point of view"—every word of which the writer of this memoir can from personal experience most heartily endorse.

P.B.-C.-R.

BOOKS.

RECENT WORK OF THE SURVEY OF INDIA.

The term "recent" must not be taken too literally. This note is intended to give an account of the Report of map publication for 1925-26, and two special reports, printed in the same pamphlet, one on the Air Survey of the Irrawaddy Delta in 1923-24, and the other on a Reconnaissance Survey in Bhutan and South Tibet in 1922. These reports reached

the Secretary of the Institution of R.E. some six months or so ago, but various matters caused the review to be delayed. The normal work of the Survey of India is the production of topographical maps of an area of nearly two million square miles. Its procedure is regulated by the report of the Survey of India Committee, which investigated the whole subject of the work of the Survey about twenty years ago. That Committee recommended a standard scale of one inch to the mile, and made some rather optimistic forecasts as to the rate of progress. In the Report under review it is stated that it will require over 6,000 sheets to cover India on that scale; that it will require 1,630 sheets to cover India on the half-inch scale; and 450 sheets to cover India on the quarter-inch scale. At the date of the Report about 37 per cent. of the one-inch and half-inch sheets had been finished. It is understood that certain areas will never be published on the one-inch scale, but the proportion is not stated in the Report. It is stated that, "Old maps on various scales are available for the whole of India, but some are very old and sketchy." A question of general interest to the soldier and geographer alike is, When will the programme be finished, and how old will the first-produced "modern maps" be when the programme is finished? And to this may be added the question, What steps have been taken to ensure systematic revision of the "modern" sheets?

The account of the Air-Survey of the Irrawaddy Delta is of singular interest. We have, in this case, a problem which air-survey was eminently fitted to solve. A flat area, difficult of approach, difficult to survey by normal means, but an area which could be tied on to external surveys. Maps of the Delta forests were wanted by the Forest Department. The country under survey consisted of "densely wooded alluvial plains, forming part of the coastal area of the Irrawaddy Delta. It is divided into six main areas by branches of the river, and each section is intersected by innumerable tidal creeks. The average height of the ground is not more than two feet above ordinary high tides. . . "

The ground control was provided in this way. The sea face consisted of broad sandy beaches, and along these beaches an accurate traverse was carried, and this was connected with the trigonometrical stations of the Burma coast series. From the traverse so fixed, chains of triangles were run up the rivers of the delta, and these river chains were connected at their northern ends along higher ground. The largest circuit enclosed about 350 square miles, and this was divided by a subtense traverse along a creek. The largest space left inside the control net appears to have been about 30 miles by 16 miles in greatest dimensions. The ground control, preparation of rectified mosaics, and the fair-mapping were carried out by No. 18 Party, under Major C. G. Lewis, R.E.

The Air Photography was carried out by Mr. R. C. Kemp, Aeronautical Engineer, in contract with the Government of Burma. The air work was begun in February, 1924, and was completed early in April of that year. The number of plates exposed was 3,795. The average height maintained by the seaplanes was about 9,400 feet, and the average scale of the photographs was about 3.4 inches to the mile. The result of unavoidable delays in starting was that the weather was not as favourable as might have been wished; but in spite of this, there were few excessive

tilts. An investigation showed that 55 per cent. of the plates were tilted at less than one degree and 35 per cent. were between one degree and two degrees. Only one plate was tilted over five degrees. The greatest difference of height, in one strip of photographs, was 200 feet from the mean; so that the greatest variation of scale, from this cause, was about one in fifty. The scale of the final map was three inches to the mile.

The Report concludes with some general observations, the most important being that it would be difficult to find a tract of country more suitable for survey by air photography, or more difficult to survey on the ground. The Report is full of valuable information, and will, doubtless, often be referred to in the future. All concerned may be congratulated on the success of the operation.

In passing from this record of the air survey of a delta to the next report, one cannot help being impressed by the great variety of work which falls to the lot of officers of the Survey of India. The next report is an account of an expedition to an almost unknown mountainous region, namely, Bhutan and South Tibet. The expedition took place in 1922, so that it is rather old history; but as the journey covered a little-known country it is important that it should be adequately recorded.

The principal object of the journey was to enable Major Bailey, the Political Officer in Sikkim, to confer the G.C.I.E. on the Maharaja of Bhutan, and to confer the *Sanad* of Maharaja on the Raja Traring near Gyantse, Tibet. The Political Officer wished to obtain a good survey of the route through the centre of Bhutan from west to east, to assist Bhutanese surveyors in the eventual survey of their country, and to assist them, also, in eventually choosing alignments for roads. "The work before the detachment was to fill as much as possible of the gap between Colonel Ryder's work of 1904-05, and the western edge of Major Morshead's exploration of 1913." The area in question was only known from the route reports of political officers and Indian explorers.

A glance at the map of India will show that Bhutan lies to the east of Sikkim, to the south of Tibet, and to the north of Assam. Its area is some 17,000 square miles. In the list which is given of previous explorations, no mention is made of Godwin Austen's route survey made in 1863, when he accompanied Sir Ashley Eden's unsuccessful mission to the court of the Deb Raja. From that date, as Sir Thomas Holdich remarked in the *Encyclopædia Britannica*, information accumulated but slowly. The expedition now being discussed traversed routes over an area of five square degrees, or some 25,000 square miles. To the north of Bhutan lies the main range of the Himalayas, with its gigantic peaks of 24,000 feet. The valleys of Upper Bhutan where the expedition crossed them "average over 7,500 feet, and are flat, open, fertile and well-cultivated, with a very temperate climate." The hills are heavily wooded. But . . "the passes are all on, or just below, the silver-fir and rhododendron line, and it is easy for the surveyor to get ideal stations, with extensive fields of view, above the vegetation."

The expedition marched from Gangtok, in Sikkim, to Bumtang, in Bhutan, where the investiture took place, a journey of 150 miles, almost due west. They then turned due north and crossed into Tibet by the Monlakarchung La, which is 17,442 feet above sea level, into Southern

Tibet. Some forty miles north again they got into the lake district of South Tibet, and of these lakes it is mentioned that the Pomo Tso, which lies at a height of 16,200 feet, is probably the highest lake of that size in the world; it is about twenty miles long by five miles broad. The party then turned west to Gyantse, and then south to Yatung and Gangtok, and so home. The whole march of 600 miles was covered in 72 marching days.

The Report gives an account of the technical work carried out, the Survey detachment being under Captain H. R. C. Meade, I.A. The conditions were generally against triangulation; but nearly 10,000 square miles of plane-tabling were executed. Considerable use was made of photographs taken with an ordinary camera; but on this point the important comment is made, "On the whole, however, the use of an ordinary camera with films entails a more laborious, expensive and inaccurate compilation in recess than the use of a survey camera." Explorers and surveyors may be asked to read, mark, learn and inwardly digest.

C.F.C.

HISTORY OF THE GREAT WAR.

Military Operations, France and Belgium, 1915. Vol. III. Compiled by BR.-GENERAL J. E. EDMONDS, C.B., C.M.G., R.E. (Retd.), *p.s.c.*, and CAPTAIN G. C. WYNNE, K.O.Y.L.I. Maps and sketches compiled by MAJOR A. F. BECKE, R.A. (Retd.), HON. M.A. (OXON). Macmillan & Co. Price 18s., with maps.

This volume contains an account of the operations in France and Belgium during the winter of 1914-1915, with narratives of the Battles of Neuve Chapelle and the second Ypres (April 22nd to May 25th, 1916), and includes a valuable chapter on the development of the supply of munitions and the recruiting and expansion of the Army in 1915.

Issued with it there are eight pages of Addenda and Corrigenda to Vols. I and II, which are conveniently printed on one side only for insertion in those volumes. The Editor invites his readers to send him any further information available or any corrections they may be able to furnish. The next volume will carry on the history to the retirement of Sir John French in December, 1915.

The year 1915 was a year of disappointments, but, as Br.-Gen. Edmonds reminds us, "It was a period of education and instruction for the British "leaders of all ranks. It taught them the handling of hastily-raised "troops and improvised formations, the employment of the new instru-"ments of war, and the methods to be used in the attack of well-defended, "continuous field positions. The battles of Neuve Chapelle, Aubers, "Festubert and Loos were most valuable lessons on the staging of an "offensive and in the comprehension of the enemy's methods, and they "must be regarded as definite steps to the preparation for the campaign of "the Somme in 1916. The most important result, perhaps, was that "the divisions of the New Armies, partially trained as they were, learnt "that man for man, unit for unit, they were more than a match for the "Germans.

"Throughout 1915 the scarcity of war material, the small number of "trained troops in comparison with the front to be held, and the uncer- "tainty regarding reinforcements—some of which, together with precious "munitions, were despatched to other theatres of war—made the task "of the British C-in-C. in France and his principal commanders immeasur- "ably more difficult than it should have been. It is not unfair to say "that, in 1914 and 1915, these officers never had the means which would "enable them to conduct defence or undertake offence with reasonable "confidence.

"After 1915, the troops at the front, as they saw the arrival of the "Kitchener divisions, the processions of heavy guns and the huge accumu- "lations of ammunition, never despaired of winning the war."

It has so often been suggested that the B.E.F. should not have attempted any offensive on the Western Front until an ample supply of men, guns, and munitions was available to ensure success, that it is interesting to read the official views on the subject. Br.-General Edmond's reply to such criticisms is as follows:—

"In spite of the unreadiness for action, the B.E.F. had not only to "fight in its own defence, but also to take part in offensive battles with "the French. . . . General Joffre could not possibly let his Armies sit "still and make no effort to drive the weakened invaders (weakened by "the withdrawal of German forces from the West to Russia) from French "territory. The instructions from the Secretary of State for War to "Sir John French directed him to support and co-operate with the "French Army and conform as far as possible to the plans and wishes "of our Ally. He was subject to constant insistence and pressure from "Generals Joffre and Foch to take the offensive. Apart from this, "a factor which naturally had much influence on the British C.-in-C., "was his knowledge that the French Army and the French public at "every opportunity expressed the opinion that the British Empire was "not making its utmost effort for the common cause. They complained "that the British troops had accomplished very little. Appreciated "purely from the British point of view the situation seemed to demand "more than patient waiting until the B.E.F. was completely ready to "strike. It had for several months been constantly hammered by the "enemy; the depression of some of the troops during the winter of "1914-15 was evident. It was of the utmost importance as regards "morale that our men should see that the enemy could be paid back in "kind and was not going to have things all his own way. These various "motives for offensive action tended to induce Sir John French to concur "in General Joffre's plans, although, theoretically, it might have been "wiser to have waited until the New Armies were trained, and guns and "munitions provided. Fortunate it was that the decision of the German "Supreme Command in 1915 to stand on the defensive in the West and "take the offensive in the East removed the danger of serious attack. "It gave the allies the initiative in France, and allowed the British the "time and leisure that they required to equip, organize, and train their "new forces."

The fatal error of the German decision to break off the Flanders offensive is now generally recognised in Germany. "As to the proper course in "the spring of 1915," writes General von Moser, "there is no doubt. "The British Army had suffered heavily in 1914, and it could only be "reinforced gradually by volunteers from the United Kingdom and "Dominions, hardly trained as soldiers. The British Army should "have been so defeated that it could never develop into an efficient "million army."

The history of this decision to divert troops to Russia is explained in a Note by Br.-Gen. Edmonds.

After Tannenberg, the supporters of the Hindenburg-Ludendorff school asserted that the war must be won in the East. General von Falkenhayn was convinced that the final victory must be won in the West. The pressure on him was, however, so great that he had to yield, and he compromised to the extent of allowing seven divisions, besides cavalry, to be sent to Russia from Flanders in November, 1914. It is recorded that, by December 19th, he had already determined to renew the offensive in France as soon as the Russians were driven back behind the Vistula, and in no case later than February, 1915. However, in January, 1915, further reinforcements were sent to Russia amounting to three newly raised Corps and one old Corps, which was replaced in France by a new Corps.

General von Falkenhayn never faltered in his opinion that a victory in the East would not win the war. He went further, he did not consider it possible to obtain a decisive victory on that front. He trusted, however, that—"the success would be big enough to check the enemy for a long time." That success was not obtained, and although the Germans conquered Poland and recovered Galicia in 1915, this could not prevent the Russian offensive in 1916. Br.-Gen. Edmonds' comment on the episode is: "Just as the two corps sent from France in August, 1914, failed to be in time for Tannenberg, the reinforcements for the East despatched from Flanders arrived too late to take part in the Lodz campaign at the end of November (Nov. 14th-24th).

It is interesting to consider what the course of the war would have been if the impatient politicians who at Christmas, 1914, conceived the idea of a diversion in the Eastern Mediterranean, had known what Falkenhayn had already decided to do as regards resuming the offensive on the Western Front. They were obsessed with the idea that matters had come to a stalemate in the West, and that with a great Navy doing nothing, the nation was wasting its energy in battering the German defences. Unfortunately, just at this moment Russia, feeling the effect of the German Eastern offensive, appealed for help both in the direction of Constantinople and in the Caucusus. Let us see what the Official Historian has to say on the subject. "In view of the situation on the Western Front and the "*subsequent* (the italics are the reviewer's) failures of the British and "French offensives in 1915, the wisdom of the decision (January 19th, "1915) to make trial elsewhere—provided that surprise was ensured—"can hardly be questioned. But once the decision was reached and "British troops were to be detached for the purpose, all attacks in the "West on a large scale—at any rate by the B.E.F.—should have been

"prohibited; for in 1915 there were neither the munitions nor the men "to sustain two serious efforts with any hope of success."

Although the Germans did not actually resume the offensive till April, that is, after the British failure to break through at Neuve Chapelle, the attack was not deferred because of any fear of the Allies getting to Constantinople. It was in accordance with Falkenhayn's original decision to resume the offensive as soon as possible. In the meantime British troops destined for France had been earmarked for Gallipoli and large numbers of Dominion troops had been retained in Egypt. What would have been the effect on Neuve Chapelle in March and at Loos in September if, after providing for the safety of Egypt, every man and gun had been sent to the B.E.F.?

General Joffre considered that the best way to assist Russia was to attack the Germans in the West, where they had weakened themselves in order to attack Russia. General Falkenhayn was probably strengthened in his decision to renew the offensive in the West when he heard of the attack on Gallipoli, by which the Allies had weakened themselves on their main front. He had based his plan on sound principles and he had the good fortune to meet a weakened enemy. The Battles of Ypres in April, 1915, were touch and go, and it was not thanks to the sound decisions of the Allied Governments that Falkenhayn did not gain a decisive victory after the first gas attack.

Br.-Gen. Edmonds has an interesting chapter on "The Plans for Operations in 1916," but it is the Official Historian who is writing, and one must read between the lines, or note the omissions, to arrive at a correct appreciation of the problem which the Government was forced to solve, and we must draw our own conclusions. The failure to ensure surprise was the cause of our disasters in Gallipoli, as at Tanga, but the basic error in Gallipoli was the decision to attack on two fronts when we had not sufficient men, guns and munitions to ensure success, even on the defensive, on the Western Front.

It is impossible in a review to say much about the narratives of the Battles of Neuve Chapelle and Second Ypres. Br.-General Edmonds has reduced the description of operations to a fine art, and it is amazing how he and his assistants have been able to produce a condensed, accurate and continuous narrative from the enormous mass of material at his disposal. Three chapters are devoted to Neuve Chapelle, eleven to the battles of Ypres. Orders of Battle and important Operation Orders are given in full as appendices. At the end of each narrative, Br.-General Edmonds adds a most valuable retrospect of the battle and its results. The sketches and maps are excellent. An innovation in this volume is a "List of Place-Names with their location," which is a feature of the French Official History. A Note on the "British lines of communication in 1915" is in continuation of a similar Note in Vol II.

Not the least valuable chapter in the book is that on "Munitions, Recruiting and Man Power in 1915." The reasons for the want of training shown by the newly-raised troops and improvised staffs in 1915 are obvious. But the student is forced to ask why

it was that there was such serious delay in providing guns and munitions?

On this subject, Br.-Gen. Edmonds begins his chapter as follows:—

"Without bearing in mind the Munitions question the difficulties of "the British Commanders cannot be fairly appreciated, nor the necessity "fully realized for some balance of the available man-power between the "home front and the fighting front during the Great War."

It was owing to the fact that the balance had not been investigated in time of peace that the British forces in all theatres, and their Allies, were to remain thus handicapped and inferior to the Armies of the Central Powers in respect of heavy guns, ammunition for both heavy and field artillery, trench stores and material of war. The French had the same difficulties as ourselves, and their troubles were accentuated by the loss of the Briey Basin and by the complete want of preparation for the expansion of their factories. The Germans, on the other hand, entered the war well equipped and prepared, and except for a shortage of gun ammunition during the winter of 1914-15, which was subsequently overcome, were not troubled in the way that the Allies were.

"The blame," writes Br.-Gen. Edmonds, "for failure to be ready "in all respects can hardly be laid on the shoulders of Lord Kitchener, "who had never served at the War Office before the War. . . At the "trial of General Stoessel in St. Petersburg in 1908, a thoughtful Russian "remarked: "We are trying, not the defender of Port Arthur but, the "Russian people." Similarly, it may be suggested that the unreadiness "for a great war was not the fault of the Army and Navy, or of any "department of State, but was the consequence of the want of forethought "of the whole body of British electors, their representatives and Ministers. "A proper system of expansion of war industries could not have been "elaborated in time of peace, or provision made in advance for the "abrogation in war of trade union safeguards, endurable only under "the peace conditions of a very prosperous community: for the whole "spirit of the country was opposed to preparations for a great war."

It will be remembered that in his recent book "Soldiers and Statesmen," Sir William Robertson did not hesitate to write that the military heads of the Army before the war in the Army Council must to some degree shoulder the blame with the Ministers and with the Nation, in that, in spite of the obvious danger of a great war and the possession of first-hand information as to the developments in war foreshadowed by the Russo-Japanese War, they did not insist on ample measures of security being taken before it was too late and too dangerous to initiate any drastic changes or take any abnormal steps without increasing the danger of war.

That the supply of munitions was for so long unequal to the demand, and that the expansion of the first years proved inadequate to cope with it, Br.-Gen. Edmonds attributes to its unprecedented nature and to "the habits of economy ingrained in peace time in the War Office, which were only slowly and unwillingly discarded by the officials concerned," but the Official Historian does not hesitate to add that the chief cause of delay was due to labour troubles, and explains clearly the extent of these difficulties and the extent to which the Government allowed itself

to be dictated to by the trade unions. "Labour, as ever," he writes, "was the root of all difficulties." During the whole winter of 1914-1915, the most obvious remedies for lack of hands, which had already been applied in France and Germany—the dilution of skilled labour by unskilled, and the employment of women—were practically beyond the reach of manufacturers, in consequence of the restrictions imposed by Trade Union rules.

These rules were—the prohibition of semi-unskilled or unskilled men doing the work of skilled men; prohibition of women doing men's work; limitation of one man to one machine; limitation of a man's output; prohibition of union men working with non-union men; demarcation of trades, that is to say, the limitation of a tradesman to a particular class of work. By the rules, for instance, the working of a row of machines by semi-skilled persons under superintendence of a skilled operator was forbidden.

Between the outbreak of war and 15th March, 1915, only some 2,000 women and 30,000 unskilled males were taken on for armament work. At the end of March, 1915, the munitions workshops were still greatly undermanned. An official census of the machinery available showed only one-fifth being used for night shifts, and most of the remainder for only 8 hours out of the 24. Of the 78,946 women who volunteered between 16th March and 4th June, 1915, only 1,816 women, owing to restrictions, could be engaged.

Br.-Gen. Edmonds furnishes us with a very clear account of the various attempts of the Government to cope with these difficulties, and describes the gradual evolution of the Ministry of Munitions, which began its legal existence on the 9th June, 1915, with the passing of the Munitions Act. It required, however, ten months to elapse before the Ministry could bring effective aid to the fighting troops. It was not until April, 1916, that the deliveries under the first contracts for gun ammunition made by the new Ministry took effect, and it was not until April, 1917, that all anxiety on the part of the military leaders was removed. The formation of the Ministry of Munitions was completed by the passing of the National Registration Act in July, 1915, and had the result that in three years, by July, 1918, three-fifths of the workers of Great Britain, male and female, were engaged in production and distribution work for the British and Allied Governments. The chapter ends with a short account of the working of the Act and the progress of recruiting during 1915-1916. Br.-Gen. Edmonds incidentally mentions that, owing to the urgent need of men in France during the winter of 1914-1915, the last units of Regular soldiers from oversea stations had to be formed into the 27th, 28th and 29th Divisions, instead of being used, as they should have been, as training cadres, a framework on which to build new battalions and new batteries.

It is impossible to put down the volume without paying a tribute to the editor and his assistants. The book with its maps is a model of what an official history should be.

H.B-W.

A HISTORY OF THE BRITISH ARMY.

Vol XII. By the Hon. John Fortescue, ll.d., d.litt. (Macmillan & Co., Ltd.) With separate volume of maps. Price 40s.

The new volume of Sir John Fortescue's monumental history covers the years 1839-1852, and describes the disastrous First Afghan War, the campaigns in Sind and Gwalior, the First China War, the First and Second Sikh Wars, the New Zealand Wars up to 1847, the Second Burmese War and the Kaffir War in South Africa. In the first, full credit is given to George Thomson and his Sappers for the bridge of boats which they constructed with improvised material over the Indus at Sukkar, further details of which may be found in Sir Edward Thackeray's *The Royal (Bengal) Engineers*, in the notices on James Broadfoot and Thomson himself. Thomson is credited with being the life and soul of Cotton's advance on Kandahar and in the storming of Ghazni, where the action of Peat, of the Bombay Engineers, Durand and McLeod, of the Bengal Engineers, and Sergeant Robertson is described in full detail. There is a small error in the index over the many Broadfoots. The one who took part in the storming of Ghazni was not George but James Sutherland, who was eventually killed, though his death is overlooked in this account, in the cavalry action at Parwan, described on pages 137-8. A similar error occurs in the reference to John Leigh Doyle Sturt of the Bengal Engineers, who is identified in the index with a lieutenant-colonel of Native Infantry who served in the Second Burmese War. John Sturt, the only engineer officer with the ill-fated garrison of Kabul, and from repeated mentions in this history one of the few wise heads among them, was killed as a subaltern in the retreat. In the account of the first siege of Multan, in the Second Sikh War, we have the first mention of Lord Napier of Magdala, and, in that of the second siege, of Sir John Cheape, who, later, in the Second Burmese War, commanded the Bengal Division, thereby achieving a record as the first engineer officer of the British Army to command a mixed force in the field. His campaign against Myat-Toon of Donubyu is described in considerable detail, and the historian adds the following comment: "Rarely have British troops been more severely tried than in this little campaign of twenty-four days; and it says much for Cheape's tenacity that he was able to hold them together through all their trials, disappointments, hardships, and privations. Forest fighting against an invisible human enemy under a tropical sun is hard enough, but, when the living foe has cholera for his ally, the combination is very formidable." It is interesting that Lord Wolseley saw his first fighting and received his first wound in this campaign.

F.E.G.S.

MY WORKING LIFE.

By Colonel the Lord Sydenham of Combe, g.c.s.i., g.c.m.g. (John Murray). Price 21s.

Lord Sydenham's autobiography is a notable book, and deals with an immense variety of subjects, on most of which—perhaps strict "Stratfordians" would not allow us to say all—his views are so evidently sound

that its careful study would almost amount to a liberal education. Fortification, strategy, Imperial Defence, the Navy, Indian Administration, the protection of the world against Bolshevism, stand out prominently among a host of other themes in which Lord Sydenham was undoubtedly in advance of his times, and undoubtedly right. And yet on closing this bulky volume, the reader is inclined to wonder if such wise counsels and such consuming industry could not have been productive of even greater benefit to his country than Lord Sydenham is able to show as the result of his brilliant and admirable career. From very early days he became engulfed in journalism, and every page of his book shows how greatly he felt the importance of educating public opinion on right lines. One is led to wonder whether it is of greater importance to educate public opinion, so far as it will allow itself to be educated, or to become a really great commander or statesman. It is evident that the two professions are antagonistic; at any rate, the adoption of journalism, even so far as it is permissible nowadays by the *King's Regulations*, is antagonistic to the advancement to high office in the Army and also probably in the Government. Lord Sydenham shows clearly that his journalistic activities lost to the Army a great brain, a great staff-officer and a great administrator. In very early days he fell foul of Lord Wolseley, and although his views on the best plan of relieving Gordon at Khartoum—he recommended the desert advance from Suakim rather than the boat expedition up the Nile—were probably sound, yet the airing of these views in the *Times* by a captain of engineers was plainly contrary to the official ideas of military discipline. His good work on the Suakim Expedition was not even mentioned in dispatches, and although his undoubted genius led to many important staff appointments, it was through the Colonial and India Offices that he gained advancement and honours. Educational propaganda did not prevent the Nile Expedition, and neither, for instance, did it prevent the attack on the Dardanelles by a fleet unsupported by an Army. It is the *man* that counts, and his advancement to the head of affairs is of more importance in a national crisis than the most influential journalism. Lord Sydenham's services to his country, notably on the Esher Committee, are a matter of history, and if he has devoted much of his life to educational propaganda, no one will deny that he is a past master of the art. The book under review is rich in educational value, and it has the advantage that most of the views set forth have been fully and conclusively confirmed by subsequent events. As such it should be widely read, and by none more than by the officers of Lord Sydenham's old Corps, who will find it a mine of information both of military and of general interest. The following quotation, although it refers to education generally, may well have been written in reference to a recent discussion in the pages of the *R.E. Journal* on the education of the Sapper Officer:—

> "Tireless workers in many different spheres are adding to knowledge at accelerating speed, the increase in the present century is enormous. But in the case of the most gifted individual, the power of assimilating knowledge is strictly limited, as are the available hours of study. It follows that education cannot make up the ever-growing deficit, that mankind will become more and more ignorant, and that the vast

majority, whose educational period cannot be greatly extended, must be left far behind in the acquisition of knowledge which may be essential. This is already happening, and specialisation, which has some obvious disadvantages, must further develop."

The Prime Minister's telegram, offering the peerage, "*Are you agreeable* that I should submit, etc.," is a delightful example of official jargon.

NEMO.

GREAT CAPTAINS UNVEILED.

By B. H. LIDDELL HART. (Wm. Blackwood & Sons, Ltd., Price 12s. 6d.)

In this book Captain Liddell Hart takes six great military leaders and gives an analytical account of their careers.

The first two, Yen Jenghis Khan and Sabutai his general, are treated together. After concise accounts of the two campaigns which established the Mongol power from China to Hungary, lessons are drawn both from the strategy and the tactics employed. It is claimed that the overwhelming successes of the Tartar hordes was due to concentration on the principle of mobility and to the fact that their armies were organised with a uniform capability for movement in every part. The deduction is that we ought "to revert to the simplicity of a single highly mobile arm," a mechanical one, thereby regaining the mobility and hitting power which we do not now possess.

The study of Marechal de Saxe comes next. The subject is given the label—Military Prophet—and in the endeavour to justify the label, the author tends to lose sight of what one imagines is the object of the book as a whole. One cannot for instance fully agree with the statement that "to-day military thought is at one with Marshal Saxe in the opinion that natural sites should be selected for permanent defences and that cities should be left unfortified." In 1914, error in this respect is said to have been paid for heavily. But it must be the nature of the site which is the deciding factor whether there be a city there or not; Liege and Paris as foci of communications will always be fortified. And did not the existence of the fortress of Paris lead to the victory of the Marne?

The story of Gustavus Adolphus is given in considerable detail and it gives a clear and interesting picture. Surely the man and his career have enough to teach us, without it being necessary to attempt to justify the title "Founder of Modern War." What is "modern" war and how can it be "founded?" The principles of war exist; it is in his application of them to the conditions of his times that the genius of Gustavus Adolphus is shown.

But the label given to General Wolfe—Grandsire of the United States—is certainly most unnecessary. Nor do we want "to estimate his place among the Great Captains." His career is, and always will be, studied by soldiers as an example of diligence and perseverance. This example stands out clearly in the story here presented.

The book is, as one expects from its author, provocative of thought. From the military point of view one cannot help regretting that the lessons, which soldiers of to-day should learn from these great captains of old, have not been drawn more definitely.

N.W.N-C.

FIELD-MARSHAL SIR HENRY WILSON: HIS LIFE AND DIARIES.

By MAJOR-GENERAL SIR C. E. CALLWELL, K.C.B., with preface by Marshal Foch. 2 Vols. (Cassell, Price 42s.)

[Reprinted from *The Daily Telegraph*, 6th Oct., 1927.]

By CAPTAIN B. H. LIDDELL HART.

When extracts from these diaries were first published in the Press, one heard comments from some of those associated with the late Sir Henry Wilson in the war, and perhaps hardly biased in his favour, to the effect that the diaries had been touched up "after the event." Such suggestions are dispelled by a study of the two large volumes in which Major-General Sir C. E. Callwell reproduces and edits a large part of the diaries, linking up the pieces by his own comments and narrative summaries. For no man, writing up his diaries for public consumption, would or could explode his own reputation for prevision and sound judgment. And that is the result of these diaries.

It may be that certain of the recollections set down in these diaries are inaccurate. So must they always be when they depend on the human memory—and the memory of a body of men is often as faulty as the memory of one man. But even if so, it is far better than they should be published now, when they can be tested and modified by other evidence, than that they should be reserved for publication fifty years hence, when there is no one alive who can controvert them from first-hand knowledge. Such "reservation" although well intentioned, is neither fair to history nor to other participants in the events recorded. More especially is this so with the history of the World War, where personal discussions and telephone conversations often played a far more vital part than the discreet instructions committed to paper. Documentary history, in fact, is not history.

Sir Henry Wilson's diaries may hit hard some of those who disagreed with him, but they will come as an equal shock to many who were his admirers from a distance. The diaries do not efface the impression of his brilliant personality, almost unique in our annals. Nor do they lessen the impression that in certain ways he was gifted beyond nearly all his contemporaries. But if they leave him securely established as one possessed of a first-rate brain, they stamp him as of third-rate judgment. He rendered great services, particularly in making possible our co-operation with the French, both in preparation for the war and in its course. But for this same reason none did so much to tie our war policy firmly to the chariot-wheels of French strategy, whose drivers' vision was ever obsessed, if naturally, by the foe on the immediate horizon.

There is a deeper meaning than General Callwell perhaps intended in his remark that "It was in . . . 1909, his third year at Camberley as commandant, that an idea came into Wilson's head which was to exert no small influence upon the history of his country . . ." This idea was that of visiting his opposite number at the Ecole Supérieure de Guerre in Paris—General Foch. The meeting ripened into an intimacy which had a great influence on Wilson's career, just as did his meeting with Kitchener in the same period—but in an opposite sense.

From the Staff College Wilson passed, as Director of Military Operations, to the War Office, where the diaries show him playing the predominant role in organising the British Expeditionary Force for its imminent test in 1914. He distributes biting criticisms with so lavish a hand that it might almost be called impartial—although Sir Edward Grey, Colonel Seely and the Navy receive the largest dose. Wilson was fully alive to the certainty of war with Germany—this degree of prevision was not uncommon—and he makes an interesting revelation under the date of Nov. 5th, 1912: "L.G. told me that at the round-table conference after the King's death the Radicals proposed conscription, but Balfour would not have it. Seely also is coming to heel and it really was amusing to hear Sir John (French) and myself pounding in the fact that unless we got conscription we were dead men."

In pursuit of his ends Wilson, however, was quite willing to use politicians of any colour, and had already sought to establish close relations with the leaders of the Opposition. Even the most unworldly and those most sympathetic to his motives, may feel a little surprise at the manner in which a high official confided in and consulted with the political opponents of the Government. These relations were intensified in the Ulster crisis, when the diaries reveal Wilson as the main-spring of the resistance to the military coercion of Ulster. Wilson's view was clearly that a good end justified any means, and it may be claimed in General Callwell's words, that "Wilson's handling of an awkward and threatening situation had put an end to all possibility of the army being used against the loyal North of Ireland." And it was at the expense of his own career, for the Prime Minister, Mr. Asquith, was at one with Lord Kitchener in objecting to Sir John French's wish in December, 1914, to make Wilson his Chief of Staff.

By then the Irish crisis was forgotten, if not forgiven, in the greater clash which had come on Aug. 4th, 1914. On Aug. 5th, Britain's line of military action was definitely decided at the great War Council, whereof Wilson reveals that Sir John French was also among those inclined to favour "the ridiculous proposal of going to Antwerp," and whereon his final comment is "an historic meeting of men mostly entirely ignorant of their subject." Lord Kitchener is the recipient of many severe criticisms in the pages that follow, and some of them will redound, and rebound, to the credit of his broad strategic vision, however slow he may have been to appreciate the need for new weapons. "He still thinks the Germans are coming north of the Meuse in great force, and will swamp us before we concentrate." They fulfilled the first and nearly the second! "K's 'shadow armies,' for shadow campaigns, at unknown and distant dates, prevent a lot of good officers, N.C.O.'s, and men from coming out. . . . Under no circumstances could these mobs take the field for two years. Then what is the use of them?" Yet these mobs ultimately decided the war, despite the handicap, as we now realise, that far too few instructors were retained to train them.

Further, repeatedly we find an undimmed assurance—shared with Foch—of an early and decisive victory on the Western front, and an almost ingenuous view of the dire situation of the enemy. It is equally disappointing to find in these diaries no hint of any reasoning based on the

great principles of war, unless we count an occasional reference to his being "in favour of sticking to the old principle of decisive force in decisive theatre"—which is both too concrete and too vague to be a "principle" at all, but merely a justification for butting one's head at a stone wall. And even here Wilson's intellectual foundations were somewhat shifting, for two years later he executed a strategical volte face. Meanwhile, however, he had been, as he shows, largely instrumental in preventing the despatch of adequate troops to the theatres he now recommends. Nor did he display more vision in regard to the technical means to victory, for we are told that on May 30, 1917, in discussion with Mr. Churchill, he "earnestly begged him not to bother his head about mechanical details as to the best form of tank and rubbish of that sort. . !"

After Sir John French, in January, 1915, had yielded to the remonstrances of the Government and appointed Robertson his Chief of the General Staff instead of Wilson, the latter was given as consolation the title of principal liaison officer with the French army. The actual role he had long been fulfilling. In this he remained, his influence none the less great because it was based on his personal links with French and the French, until Haig replaced French in December, 1915. The change obviously snapped an important link, and Wilson was now given command of the Fourth Corps. Suffering the loss of some trenches on the Vimy Ridge in May, he was unlucky in having no opportunity to win laurels in attack later, as his corps was beyond the flank of the Somme offensive. His account of a conversation with Clemenceau produces the interesting revelation that the latter thought "an early offensive on the West on our part sheer madness. . . . He urged Haig to stop all great offensives until Russia was ready—right on to this time next year if necessary." Wilson's own reaction to reality was beginning, for on May 6 he relates that he told Robertson—now C.I.G.S.—that "there was no reasonable chance of success with the balance of forces as they are. . . . He said Joffre was pressing for it, being himself pressed, but I said I did not care a rush who pressed. . . . It was mad to gamble in that way." After the futile losses of July 1, Joffre is related to have pressed Haig, to the pitch of rudeness, to repeat his attack on the unbroken front Thiepval-Serre, but Haig stood firm. However, a year later, it is related of the Passchendaele campaign that Pétain, far from begging Haig to attack, declared that "Haig's attack towards Ostend was certain to fail, and that his effort to disengage Ostend and Zeebrugge was a hopeless one." Even Foch, the irrepressible, "wanted to know who it was who wanted Haig to go on 'a duck's march through the inundations to Ostend and Zeebrugge!'"

After a mission to Russia, which had helped to disillusion Wilson on the score of Russian support, two months out of employment, and then a spell in a home command, the Italian disasters paved the way for Wilson to bring about his new scheme of a Supreme War Council, with himself as the British military representative. But the diaries show that he was rather an opponent than a protagonist of a single command in the person of a generalissimo, and that when this Versailles appointment became a stepping-stone to the post of C.I.G.S. in place of Robertson, Wilson strove

for the same subordination of the Versailles representative to the C.I.G.S. which Robertson had insisted upon—to his own downfall!

The diaries also reveal that while at Versailles, in December, Wilson had received a "very secret" wire saying, "In view of the determined peace movement upon the part of the Central Powers, the Prime Minister is anxious to know your personal views as to prospect of our improving our position by continuance of war. The most vital factor to be military outlook." Any dreams of peace, which Wilson did not encourage, were soon blasted by the German onslaught. The news caused more depression at home than in France. "We are very near a crash. Lloyd George has on the whole been buoyant. Bonar Law most depressing. Smuts talked much academic nonsense. Winston a real gem in a crisis, and reminded me of August, 1914." Wilson helped to secure Foch's appointment to co-ordinate the action of the Allied armies, but in the succeeding months their cordial relations were often strained. Wilson had difficulty in obtaining a decision as to whether the British should hold on to the Channel ports or on to their junction with the French; he tells us also of Geddes's scheme to plank sixteen heavily-armed Martello towers across the Channel to block it.

He reveals also that, as late as August, Foch merely "wants this year to disengage the lateral railways," while Haig declared that "we ought to hit the Boche now as hard as we could, then try and get peace this autumn." Nor did Foch seem to show a deepened appreciation of material factors, for on Sept. 30 he "insisted again upon our keeping up sixty-one divisions, building less ships, less aeroplanes, less tanks, &c. The same story." Again, "Foch wants us to do all the work. The French are not fighting at all, and the Americans don't know how, so all falls to us." A few days later, however, all realised that peace was in sight, and the question of terms arose. Haig, with practical knowledge of the situation, was for mild terms, Wilson for stiffer, but not so stiff as some wished, for he considered that "our real danger now is not the Boches, but Bolshevism." The greater part of the last volume, however, is occupied with Wilson's piquant revelations of the post-Armistice wrangles between the Allies, with the "frocks," and particularly "my cousin"—President Wilson—as the villains of the piece.

MAGAZINES.

COAST ARTILLERY JOURNAL.

In the January number the O.C. of what corresponds to one of our T.A. Coast Defence Artillery Units, suggests a very speedy method of written examination for testing N.C.O's and others after a course. His suggestion is to arrange a paper that will cover the subject, can be answered in two minutes and corrected by the instructor at the rate of 150 to the hour.

The complete examination might contain such papers on different subjects or portions of a subject.

There are three general types of question—the most common, in which the student determines whether the statement as it is written is true or false and indicates his opinion by scoring out the answer he judges incorrect; the second is the "selective" type, in which he selects one of three or four alternative statements, by leaving unscored the one which he deems to be the correct answer; the third is the "completion" type, in which the student writes in a prepared space, the word or figure required to complete a statement presumed to be true.

To penalise guessing, the rules of scoring require that two points be deducted from the total score for each question answered incorrectly, while only one point is deducted if such question be left unanswered.

A few type questions are shown below :—

1 The inside of the bore should be coated with grease or oil except when it is being fired. True. False.

2 All brass or bronze parts of a gun should be protected by a coat of oil. True. False.

Write the names of the lubricant used in the following parts :—

3 (*a*) The recoil cylinder .....

4 (*b*) The breech block .....

5 (*c*) The grease cup .....

6 (*d*) Heavy gear .....

7 Emery cloth and sand paper should be used on bearings to keep them bright. True. False.

8 After firing, a gun should be cleaned with —hydrolene oil—kerosene—engine oil—soda solution.

9 Water is better than oil for cleaning the bore of a gun when it has been fired. True. False.

10 Kerosene is a good lubricating oil. True. False.

11 There are 1—6—16—26—36 buffer discs in the shock absorbing assembly of a machine gun.

12 The steam tubes are made of bronze—iron—rubber.

13 Name the spring which forces the extractor to pull the live cartridge from the belt as the bolt moves to the rear. .....

The February number gives a condensed report on the recruiting, organization, education, care and maintenance of the existing Red Army of Soviet Russia; its strength and its inherent weakness. Of the latter the principal cause is said to be the want of education of nearly all ranks. A suggested remedy is to militarise all the Civil Schools, so that they may be entirely under the control of the politico-military chiefs, who can thus arrange the education of the whole country to suit their actual requirements and aim solely at efficiency as it is to-day accepted in Russia.

This method may seem logical at first sight, but, like the whole of the anti-moral teachings enforced in that country, it contains the seed of its

own ultimate extinction. Human nature cannot stand the psychological strain of such explosive transformations, but slowly reacts to the mass desire for liberty to enjoy the fruits of labour in peace.

The May number contains a transcript on the effect of artillery fire when applied in mass.

A thesis had appeared in France before the war to point out the great mistake made by French artillerists in 1870 when they rejected the practice of massed artillery fire. Theoretically the application of this rule was accepted during the late war, but in reality we saw the greatest volume of such fire that the world has ever known, dispersed on various missions. Destruction, neutralization, counter-battery, barrage, in fact, dispersed in space as well as time.

The effects of mass, that is, the sudden and adjusted concentration of a mass of metal on well-determined objectives, were attained at times and were always a great success.

The writer presses for a Corps organisation that would put the actual direction of the entire volume of artillery in the Corps under the hand of the Commanding Officer of the Artillery of that Corps, when required. At present the divisional Artillery is taken from his hands and he tends to become a technical adviser and distributor of ammunition.

The principal obstacles in the way of the infantry are the enemy artillery and the enemy machine guns. Our artillery should deal with them successively, for to strike both objectives at the same time is to practise dispersion.

In defence, the same. All guns of the Corps must block the way of the enemy infantry. If a suitable opportunity occurs they may all be used in an attack on his artillery.

The inevitable adoption of *matériel* with very long range and great output, and of firing methods doing away with preliminary adjustments, will be necessary in the future. When the battle takes place the artillery will take part in it by means of sudden concentration of masses. The roar of the guns will be uninterrupted as before, but the objectives will be destroyed by weight of metal in succession and in the order most advantageous to our infantry advance.

Whether in attack or defence we should avoid dispersion of trajectories by trying to strike several objectives at once.

To destroy each successive target once and for all with an annihilative flood of fire would give a better and more useful final result than the dispersion of that flood into numerous rivulets dissipated both in space and time.

This doctrine of mass effect need not exclude liaison between gun and bayonet. On the contrary, the liaison can be effectively obtained through the higher ranks, and not by dividing up the Corps artillery and handing the fragments to Divisions. The latter will then be in reality "Light Divisions," and able to go anywhere.

The August number contains an essay on the preparation of a suitable scheme for mobilising the Power Industry of the entire country in case of war.

The author begins by carefully stressing the moral difference between

an offensive war of aggression and defensive preparations which are only intended to discourage a wanton attack on his native land.

These peace propaganda statements are difficult to accept when put to the test. Such proposals, like all others for warlike procedure, can be used for international criminal purposes just as easily as for the most righteous war of defence. It is very difficult to cast out the beam that is in one's own eye.

The best way to prevent shortage of power in one area with possibly a surplus in another is adequate transmission; this again means balancing power on national lines by suitable distributing grids.

A map will then show where shortage and surplus may be located, and rectification is comparatively simple when ample notice can be given to balance the irregularities.

An "Emergency Power Director" should be appointed in case of need, who would be responsible for the effective utilization of power facilities. He would hold a watching brief only, until such time as a region was shown to be suffering from inadequate power, when authority would be given for his control to function.

Members of his directorate would then take over the management of the zones indicated in the authority and be responsible for them until they could be handed back to their own managers without detriment to the nation.

It might not be necessary for the Emergency Power Director to act in peace time, but a small nucleus staff should exist for the purpose of collating information as to existing or proposed schemes for Power supply or transmission, so as to be able to direct them along the best channels for national use with an eye to the possibilities of war.

* * * * *

A theory about "accidents"; they are caused and do not happen. Except those of natural origin, such as earthquakes and cyclones, industrial experience points to the conclusion that they are the effect of a preventible cause. The cult of the "Safety First" movement has proved the truth of that hypothesis. This being so, they are not accidents at all. We know that the incidence of fires can be reduced, that some chauffeurs have many accidents, while others, driving under similar conditions, have none or almost none.

If the safety habit could once be established, it would not be difficult to maintain. Instead of interfering with normal work, safety efforts promote production; both quality and output would be improved as well as general efficiency and industrial harmony. Safety devices and instruction could be looked upon as an insurance premium paid in cash or time or trouble, but one which would carry a higher return than any other form.

D.M.F.H.

INSTITUTION OF MECHANICAL ENGINEERS.

The Proceedings of the Institution of Mechanical Engineers for January to May, 1927, contain a lecture delivered by Capt. C. H. Kulneon "The

development of mechanical vehicles for general load-carrying duty in the Army." The paper deals mainly with the development of the six-wheel lorry, which has proved itself to be a great step in the progress of mechanising the army. The work of development has progressed considerably since this paper was written, but it is, nevertheless, worth studying, because it describes the principles which underlie the successful working of those six-wheel lorries. The system of taking up the torque reaction by horizontal links is clearly explained and is very interesting to the mechanical mind; the necessity of this complication has been questioned and some vehicles have been constructed without it, but the results obtained from vehicles which employ this system of suspension are very striking, and in the trials with the Mechanised Force this year the six-wheeled vehicles proved themselves to be a very great success. The development of these vehicles has raised great interest in civilian circles and their commercial employment is progressing steadily. The discussion which took place after the lecture is fully reported in the proceedings and is of considerable interest. There is little doubt that this work represents the greatest advance that has been made since the War towards mechanisation; it was carried out by officers and retired officers of the R.A.S.C., who were fully qualified mechanical engineers, and is a striking example of the necessity of employing officers, who are qualified in this way, in the work of developing transport or fighting vehicles.

G.Le Q.M.

BULLETIN BELGE DES SCIENCES MILITAIRES.

(1927. TOME I. NOS. 4 to 6 INCLUSIVE.)

Les Opérations de l'Armée Belge. Events of October 16/19, 1914, are dealt with in these numbers. The situation and operations on the Belgian front on October 16 and 17 are described in No. 4, in which an outline is also given of the latest intelligence relating to the enemy received at the Belgian G.Q.G. and the operations which it was intended that the Franco-British troops on the Belgian right should carry out on the 17th. It was on this date that the Belgian High Command first learnt that a newly-constituted German Fourth Army, whose Headquarters were then at Ghent, was on the line Ypres-Nieuport, and advancing against the Belgian front, which extended at the time from Boesinghe to the North Sea, with the intention of breaking through to Dunkirk. On the evening of the 16th, this German Army was reported to have reached the line Thorout-Ostend. The instructions issued to the French Tenth Army provided that it should, in co-operation with the B.E.F., which was now holding the Allied front between Armentières and Passchendaele, on the 17th strike an offensive blow in the direction of La Bassée. The opening phase of the Battle of the Yser is described in No. 5 of the *Bulletin*, in which a sketch map is provided showing the situation on the Belgian and British fronts on the 18th; in it is also set out the composition of the Belgian Army on this date. The Belgian losses had been so serious that the two cavalry divisions were reduced to 3,285 sabres, 900 rifles and 14 field guns, whilst the six infantry divisions totalled only 52,683 rifles, 1,503

sabres, 278 field guns, 28 howitzers and 184 machine guns. When the battle opened, the Allied force in Flanders North of the Lys, available to oppose the six cavalry divisions and the leading twelve infantry divisions of the German Army, consisted of a total of eight cavalry divisions (one Belgian, four French and three British) and 9½ infantry divisions (4 Belgian, 2½ French—territorials—and 3 British—one of these was still in the act of detraining). The events of the 19th are described in No. 6 of the *Bulletin*; on this date the German III Reserve Corps came into collision with the Belgians, and a series of severe engagements took place along the whole Belgian front, and at the same time the main body of the German Fourth Army completed its deployment southward of Bruges. The French II Cavalry Corps and the British 7th division were now obliged to yield ground, and, on the evening of the 19th, the line held by the French and British troops extended northwards from Armentieres, through Passchendaele and Westroosebeke, to Zarren (E. of Dixmude).

Avant postes couvrant une position défensive en guerre de mouvement. Major-General Donics, the author of the original article, which appears in No. 4 of the *Bulletin*, points out that views in relation to the employment of outposts differ to a material extent; he discusses some of the practical problems connected with the subject in the light of the Belgian Field Service Regulations.

Les mitrailleuses dans la défensive—Coup d'œil général. The original article is published in No. 4 of the *Bulletin*; its author, Colonel Stroobant, examines the subject mainly from the point of view of the doctrines laid down in the official publications prepared for the use of the Belgian Army.

Le principe de la bataille. The 9th and 10th parts of the article under this title contributed by Major Jobe appear in Nos. 5 and 6 of the *Bulletin*. The 1917 operations of the Great War are dealt with in these two parts; the general situation at the end of 1916 and the preparations for the 1917 campaign are briefly reviewed in No. 5, whilst the Franco-British offensive, the operations on the Western Front which succeeded this offensive, and the Battle of Caporetto (October 24, 1917), are dealt with in the following number. Major Jobe suggests that General Nivelle's failure on the Western Front was due to the latter's disregard of the essential principles of war: *inter alia*, the part of the enemy's line against which the offensive was delivered was not well chosen; the element of surprise was entirely absent, owing to the circumstance that Nivelle's plan of campaign was loudly proclaimed from the house-tops; the fact that the retreat of the Germans in the early days of 1917 necessitated some modification in the French plans as originally drawn up was either overlooked or disregarded. Major Jobe suggests that Ludendorff's failure on the Italian front was due to the fact that he did not sufficiently concentrate his effort against the Italians; he failed to appreciate that for the purpose of annihilating the enemy of the Central Powers in the southern theatre, it was necessary to envelope both his flanks; that is to say, with the attack in the region of Plezzo there should have been combined an offensive from the Trentino in order that the enemy might have been completely encircled. Ludendorff made the mistake of retaining too large a part of the troops at his disposal on the Russian front, although the Czar's troops were then completely beaten, and the collapse of the Russian

Empire was already imminent owing to the disintegration of its army and the overthrow of its social structure.

Défense en profondeur. Répartition des moyens de feu, principalement des mitrailleuses. The original article is contributed by Major-General Donies in No. 5 of the *Bulletin*; it consists of useful comments on the instructions contained in the recent issues of the Belgian Manuals entitled "L'Infanterie au combat" and "Emploi tactique des grandes unités."

Application des feux dans la défensive. Major-General Donies is also the author of the original article under the foregoing title; it is published in No. 6 of the *Bulletin*. The contents of the article are based to a great extent on the doctrines enunciated in the recent issues of the Belgian and German Field-Service Manuals.

W.A.J. O'M.

REVUE MILITAIRE FRANCAISE.

(*April*, 1927.)—The fifth instalment of *Les étapes de guerre d'une division d' infanterie* covers the period January-October, 1917. It now appears that the author, Lieutenant-Colonel Laure, was Chief of Staff of the 13th Division up to July, 1917, when he was appointed to the Operations Branch at G.Q.G., and in this number Commandant Jacottet collaborates with him. One salient point of the instalment is the description of the attempts to undermine the discipline of the division in the spring of 1917. These attempts were, fortunately, nipped in the bud, and the division regained its confidence in the action of La Malmaison, in October, 1917. This was a definitely limited attack, supported by a great weight of artillery and tanks. The operations proceeded "according to plan," and the morale of the division rose accordingly. The description of the carefully-arranged plans for this attack, carried out under the orders of Marshal Pétain, is interesting.

In the second and final instalment of *L' art de la guerre*, General Canonge gives a series of comments on features of the Great War, with special reference to the influence of the Commander-in-Chief on his Army, and indicates briefly the developments to be expected in the various arms. After discussing the probable character of the next war, in which science is bound to take a greater part than heretofore, he finishes with a plea for preparedness, quoting Bacon's saying that a nation which forgets how to use its arms is bound to be attacked on all sides.

In concluding *Avant l'offensive Allemande sur Verdun* Lieutenant-Colonel Paquet describes the intelligence received of the enemy's intentions during the month preceding the attack. There was no doubt that an attack was meditated; as a consequence the troops and particularly the headquarters of units were continually disturbed owing to the nervousness of the higher command. The information refers to the Herbebois sector and is given by an intelligence officer who was on the spot. Some useful conclusions for intelligence officers are drawn, and the need for offensive patrolling is shown very clearly.

La Manœuvre Offensive, by Colonel Moyrand, is designed to illustrate the principles of offensive action as controlled by the higher command. The second battle of Guise, October-November, 1918, in the Laon-La

Fére sector, is taken as an example. The first instalment is devoted to a description of the general plan of the G.O.C. 1st Army, and the subsequent operations, which were uniformly successful. The value of the article is reduced by the inadequacy of the accompanying map.

Capitaine de Gaulle completes his sketch *Le Flambeau* in this number. This gives, in dialogue form, an interesting and clever picture of the soldier of Napoleon's days.

(*May*, 1927.)—The sixth instalment of Lieutenant-Colonel Laure's and Commandant Jacottet's *Les étapes de guerre d'une division d'infanterie* covers a period of comparative rest in the Vosges sector for the 13th Division, followed by heavy fighting during the break-through of the Germans on the Aisne front in May, 1918. The description of this fighting is too complicated to follow with ease, but the authors' comments are of real value. Apparently the French higher command, and especially Marshal Pétain, realised the necessity for considerable depth in defence during trench warfare; but this lesson had not really percolated through to the troops before the German onslaught. Unfortunately, the enemy selected a sector where the defences were still based on out-of-date methods. The difficulties of moving troops in lorries reminds one of some of our own experiences on the last army manœuvres.

Colonel Chavineau, in *Points d'appui et centres de résistance*, writes with the object of clearing up the misapprehension which he considers to exist in the French Army with regard to the regulations on the best method of defence. He defines a *point d'appui* as a defended locality with a garrison of about a company, while a centre of resistance is applied to a larger defensive area. The writer considers that there is a tendency to lull the reader of the regulations into a false sense of security by the advocation of the holding of positions by small forces organised in mutually supporting localities. He seems, however, to be rather biassed by conditions of trench warfare, and does not pay sufficient attention to the need for active defence, especially when only small forces are available.

In the second instalment of Colonel Moyrand's *La Manœuvre offensive* the writer studies the principles which should govern the action of the higher command during an offensive battle. The general principles deduced are that, first, a plan of manœuvre, giving a general direction to the operations, is required, then, during the operations, all decisions must be taken to further the object in view. For this purpose the higher command must centralise and decentralise according to the strength of the opposition.

General Camon begins an interesting article entitled *La catastrophe de Tannenberg* in this number. He describes clearly but briefly the negotiations, between the French and Russian Staffs, which led up to the Russian plan of campaign, and then describes the Russian operations up to the time of arrival of Hindenburg and Ludendorff on the eastern front. The Russian movements are clearly explained and illustrated by two sketch maps.

Tirs d'artillerie au profit de l'infanterie, by Lieutenant-Colonel Menjaud, is an excellent little article on the subject of artillery giving support to the infantry—one of the eternal problems of war. According to the writer, the infantry have acquired the habit of asking either for "creeping"

barrages, or concentrations. He points out that in many cases neither type of fire is advisable or practicable, and establishes a strong plea for the practice of the infantry stating their requirements and leaving the artillery to judge the best means of carrying them out.

(*June*, 1927.)—The seventh instalment of *Les étapes de guerre d'une division d'infanterie*, by Lieutenant-Colonel Laure and Commandant Jacottet is most interesting, as it describes in detail the part played by the 13th Division in General Gouraud's famous defence of the Champagne sector in June, 1918. It was not till this battle that the lessons of "Directive No. 4," issued by G.Q.G., in December, 1917, were really taken to heart by all commanders, and the result was shown in the great success obtained by General Gouraud and his troops. Special attention was paid to observation posts, and every possible means of communication for giving warning of the German attack, and the success obtained by the intelligence officers cost the lives of a large number of them. The various stages of the defensive organisation and barrages are well illustrated by maps.

In the third instalment of *La manœuvre offensive* Colonel Moyrand describes separately the operations of the three corps of the First Army (15th, 36th and 8th), in October, 1918. The plan of the corps commander is given in each case, followed by a brief description of the course of operations.

Capacité de combat des grandes unités, by Colonel Lucas, is a discussion of the capabilities of a formation (particularly a division) as regards the front it can cover and the depth to which it can penetrate in attack. Before the war, frontages only were considered in the French regulations; as the war proceeded the factor of exhaustion, under trench warfare conditions, caused the question of penetrative power to be considered as well. In this instalment the writer discusses the growth of this idea, up to the reorganization of the division in 1916, from two brigades of two regiments each to a divisional infantry of three regiments under one commander. It is pointed out that in the post-war regulations, both frontages and depth appear to be left to the discretion of the higher command.

General Camon concludes his article *La catastrophe de Tannenberg* in this number. After describing briefly the German plan and its success, he makes some interesting comments and suggests a manœuvre which would have given the Russians the best chance of success. His idea is that Rennenhampf should have drawn Von Prittwitz as far east as possible, while Samsonoff struck north-west and cut off his retreat. It is an attractive solution, but knowing what we do of the Russian unpreparedness for war, one cannot but be doubtful if they were capable of carrying out such a manœuvre. General Camon supports his arguments well with quotations from Napoleon's orders.

Etude sur Shanghai, by Capitaine Girves, is a sketch of the position and organisation of Shanghai, including its government, commerce, industries, etc. The peculiar administration of the various settlements is clearly described, and the article is full of information, though inclined to be statistical.

(*July*, 1927.)—The eighth instalment of *Les étapes de guerre d'une division d'infanterie*, by Lieutenant-Colonel Laure and Commandant

Jacottet, describes the part played by the 13th Division in the attacks in Champagne (26th September-11th October, 1918), and the final break-through towards Mezières, in November, 1918. The good results which followed the careful preparation of the first operation are very noticeable, and the authors' comments on the varying success of the infantry, according to the artillery support available, are most interesting. When the infantry at first began to out-distance the artillery, they failed; but soon found the use of Stokes' mortars to neutralize the enemy's machine-guns, and so help themselves forward. The need for close support artillery, as the operations became more mobile, was very marked. The article concludes with an excellent commentary on the general strategy of the closing stages of the war, and shows how by a sound plan the higher command can minimise the losses of the troops who have to do the fighting.

Colonel Moyrand completes *La manœuvre offensive* in this number. He points out how seldom one finds a "plan" written down in the archives of any formation, although every commander should have a "plan" in his mind. He then describes the control exerted by the higher on the lower formation, according to the type of operation, and concludes with a table giving the proportion of arms, other than infantry, allotted to certain corps towards the end of the Great War.

In the final instalment of *Capacité de combat des grandes unités*, Colonel Lucas discusses at some length the frontages over which it was found that a division could fight during the great war, according to the type of operation. He then points out that the question of frontage is generally evaded in the post-war manuals. He concludes with a plea that the division, rather than the corps, should be considered as the fighting formation, and is of the opinion that a division of four regiments would be more efficient than the existing three regiments division.

Propos de passerelle, by Pierre Génêt, is a discussion of the role of the navy in war, in the form of a dialogue between the captain of a torpedo boat destroyer and an army major. The discussion takes place on the bridge of the destroyer during naval manœuvres, and the sailor convinces the soldier of many uses of the navy which had not occurred to the latter. The article is interesting and attractively written, although it contains little that is new.

Les événements de Chine, by Capitaine Girves, is a recital of the military operations in China from the summer of 1926 to the end of May, 1927, culminating with the rupture between Chiang-Kai-Sek and the Hankow government. Two sketch maps make the operations reasonably easy to follow.

Cross country de motocyclettes, by General Camon, is a short plea for research in the use of motor cycles across country, whereas at present speed only is the universal object.

(*August*, 1927.)—The concluding instalment of *Les étapes de guerre d'une division d'infanterie* consists of a most interesting discussion of the lessons to be learnt from the various stages which the 13th Division passed through during the Great War. The writers agree with the opinion expressed by Colonel Lucas, in the July number, that the division and not the corps should be the battle formation, but they are firmly of the

opinion that the divisional infantry should not be increased to twelve battalions. Strong exception is taken to the "dictum" that the infantry is the decisive arm, and the opinion is expressed that the more infantry a division contains the more likely its commander will be to waste his infantry. An interesting comparison is given between the progress achieved by the one twelve-battalion division (from Morocco) in the French Army and other divisions in the same sector, and the results certainly appear to indicate that the authors are right in their contention.

A la droite de la 5e armée française en août, 1914, by Commandant Padovani, is a description of minor operations on the Meuse, between Givet and Namur, which, though not of great importance in themselves, had considerable influence on the decisions of General Lanrezac, commanding the 5th Army. This instalment brings us up to August 23rd, just before the German main attack was delivered. On this day, by a still obscure chain of circumstances, the crossings of the Meuse were only guarded by one division, instead of the whole of the 1st French Corps.

A propos d'une récente mission des Chambres de Commerce d'Algérie vers le Niger, by Général Meynier, begins in this number. This is an extremely interesting article on the subject of communications in the Sahara, and foreshadows the complete conquest of the country, in the near future, by the "six-wheeler" and the aeroplane. Two expeditions are described, first by the Algerian Chamber of Commerce from Algeria to the Niger, and, secondly, by a band of raiders from the Western Sahara, who were able to carry out an extensive raid through a large part of the territory and to return unscathed to fastnesses in the Spanish zone. The success of the raid points to closer co-operation between France and Spain in future. The lessons of these two expeditions will be discussed in the next number.

L'artillerie antiaérienne à l'étranger, by Commandant Vauthier, is a discussion of the technical methods and organisations of anti-aircraft artillery in the United States, Germany and Italy.

Guillaume le Conquérant à Hastings, by Colonel Revol, is of historical interest, especially in view of the recent celebrations of the 900th anniversary of the Conqueror's birthday at Falaise. What stands out regarding the military character of William is his organising capacity; he must have been a first-class Quartermaster-General.

(*September*, 1927.)—*Douaumont pendant l'occupation Allemande*, by General Rouquerol, is a description of the German occupation of the fort of Douaumont, from its capture by the Germans in February, 1916, to its recapture by the French in October of the same year. This instalment is mainly devoted to the French efforts to recapture the fort in May, in which they were partly successful until driven out by minenwerfer. Like other "cock-shies" so familiar on the Western front, the fort must have been a living hell to the defenders; but its value as an observation post necessitated its occupation. The narrative is taken from a German book based on official documents.

La manœuvre des destructions, by Lieutenant-Colonel Bailly, is an interesting discussion of the employment of demolitions, with special reference to the Western front during the Great War. The writer considers that, in future, commanders should regard demolitions as an

additional arm, to be employed as demanded by circumstances. The difficulties of blowing the charges at the right time, except during a pre-arranged manœuvre like the German retreat to the Hindenberg line in 1917, are fully discussed and illustrated from the experiences of the various 1918 retreats. It appears that on nearly every occasion the responsibility fell on the N.C.O. detailed to fire the charge, in spite of all previous arrangements. The writer foreshadows the use of wireless to control demolitions in future, but the demands for wireless are already so many and varied that one must be inclined to doubt its extension to such a use.

The second and final instalment of *A la droite de la 5e armée française en août* 1914, describes the crossing of the Meuse by the German Third Army on the 23rd August, and a successful counter-attack by the French 1st Corps at Onhaye. This corps had to be recalled from the general northward advance of the 5th Army to meet the threat to the right flank. It appears that the root of the trouble was the gap between the 4th and 5th French Armies, which would have allowed the Germans to cross the Meuse whatever the dispositions made by the 5th Army.

The second instalment of Général Meynier's interesting article, *A propos d'une récente mission des Chambres de Commerce d'Algérie vers le Niger*, foreshadows the construction of the trans-Saharan railway as soon as the country is rendered safe from raids similar to the one described in the first instalment. The success of the "six-wheeler" and the aeroplane, and the development of wireless, appear to offer a solution to this problem.

Commandant Desmazes begins an important article entitled *Les victoires serbes en* 1914 in this number. He considers that the success of the Serbian Army at the outbreak of war was far more important than is generally supposed. This instalment outlines the history of Serbia and her relations with Austria prior to the Great War, and describes the plans of the two nations up to mobilisation.

H.A.J.P.

REVUE DU GENIE MILITAIRE.

(*March*, 1927.) This number contains an interesting article by P. Kandavrov on the Mourmansk railway. Archangel was useless as a port during five or six months of the year owing to the White Sea being blocked by ice, and the only connection between it and the Russian railway system was a metre gauge-line of feeble capacity. Mourmansk is a natural harbour at the end of the Gulf of Kola, but the nearest rail-head was at Petrosavodsk, 1,050 kilometres distant. The railway was begun in March, 1915, and finished on November 16th, 1916. Its construction was accompanied by many difficulties, the greatest of which was the sparsity of the population. In one stretch of 350 kilometres there were only four small villages near the railway. Imported labour included Mohammedans from the Caucasus, who were rather handicapped during Ramzan by the long Arctic day. Earthwork could only be done during the summer. The worst natural obstacles were the marshes and rocky outcrops, a million cubic metres of rock had to be removed. Bridges and culverts had to be constructed to the number of 1,110 of a total

length of 16,800 metres. They were all made of tree trunks. The bridging of large rivers was difficult, as the current was about four metres per second, and all the river beds were rocky. The girders were all made of round trunks of the type invented by the Russian engineer, Borovik, something like the type called after the American, Howe. There is a drawing of a bay of the bridges 250 metres long over the Kem. Each bay consisted of six girders about 78 feet long, the panels being about eight feet wide and ten feet high. The piers were of cribwork made of tree trunks and filled with stones, resting straight on the river-bed. It is a fine example of heavy bridge work.

(*April.*) There is an article on Italian Military Architects of the Renaissance such as Giotto, the architect of Florence Cathedral, Bounelleschi, Michael Angelo and others, with descriptions and illustrations of some of their works.

(*May.*) There is a continuation of the above article. Général Camon has contributed an article, "Position under cover of the Passarge," consisting of a brief study of Napoleon's orders and instructions when his armies were collected in East Prussia and Poland during February and May, 1807. The first part describes the general dispositions of the covering force on the Passarge, the second part the offensive movements of the Russians, and the third part describes the plan for threatening the rear of the enemy round the left flank. The article contains numerous interesting extracts from Napoleon's correspondence.

There is a note by Lieutenant Lambert and Captain Josserand on a collapsible wooden frame, for use with the Habert bag instead of straw, for forming the floating pier of a foot-bridge.

(*June.*) There is the beginning of a long article by Lt.-Colonel Baillis on River Crossings. The first part describes such operations during the war 1914-1918.

(*July.*)—The second part of the above article deals with "The present doctrine of the crossing of rivers and its application on the field of battle." The third part contains an account of the passage of the Piave by the French and Italians on October 26, 1918.

A.H.B.

THE JOURNAL OF THE UNITED SERVICE INSTITUTION OF INDIA—JULY, 1927.

In this number appears an article on the Kadir Cup. The writer claims that pigsticking is the most valuable of all sports for developing soldierly qualities, an opinion with which those who have had an opportunity of enjoying the sport will agree.

During the war, pigsticking was necessarily in abeyance, and since then many of the pre-war tent clubs have not been restarted. Expenses have gone up, and the new generation is more interested in mechanical means of transport than in horses.

The Kadir Cup is the Blue Riband of pigsticking, and is run in the Ganges Kadir (country bordering the river), hunted by the Meerut Tent Club. It was started in 1871 by Forbes, I.C.S., and has been competed for ever since except in 1879 and 1880, during the Afghan War, and from

1915 to 1918. Before the War, the I.C.S., Gunners, and British and Indian Cavalry used to supply most of the competitors. Now the I.C.S. and Indian Cavalry have almost entirely dropped out.

The Kadir Cup week is a most enjoyable one for spectators and competitors alike. There are four camps—Bachelors' Camp, Ladies' Camp, the Horse *Bagh*, and the Elephant *Bagh*. The Elephants are used for beating, and carry spectators and competitors not riding. During the week preceding the meeting the pig in all the outlying jungle and *jhils* are driven into the hunting country. The actual beating is done as follows: "First comes a line of about 150 coolies, then, about fifty to seventy-five yards behind, are the elephants. The cooly line is controlled by the two *shikaris* on camels, and the Honorary Secretary, who is in command of the whole. The elephant line is controlled by the Field-Master, who is on a howdah elephant just ahead of the main line. There are usually five heats riding, three in front of the line of coolies, and two right and left rear of the line of elephants to deal with any pig that breaks back."

A heat generally contains three riders, and as soon as a pig is put up, the heat nearest it is taken up to it by the umpire, and, if the pig is rideable, the umpire sees that the riders are together and slips them with the command, "Ride." First blood wins the heat, and the unsuccessful members of the heat should go on and kill, if possible.

This year there were eighty-one starters, a record since the war, and Scott-Cockburn, of the 4th Hussars, created another record by winning for the third time on *Carclew*.

The Kadir Cup is followed by the race for the Hog Hunters' Cup, which H.R.H. the Prince of Wales won during his visit to India.

P.H.K.

MILITARWISSENSCHAFTLICHE UND TECHNISCHE MITTEILUNGEN.

March-April, 1927).—*Has the Development of Tanks passed its Highest Point?* by Major Heigl.

This question crops up from time to time (*v. Militär Wochenblatt*, March, 1926) in those armies which are not permitted to possess tanks, and where there is, consequently, a certain ignorance of tank-development.

An illuminating answer to the question is afforded by Major Heigl's *Taschenbuch der Tanks* (reviewed in *R.E. Journal*, December, 1926), to which—so rapid is the progress in these matters—the author has already been obliged to publish a supplementary volume.

In this article Major Heigl himself answers the question. He first traces tank-development through four periods, two belonging to the War and two being post-War :—

First period, 1914-16. The tank's form was settled.

Second period, 1917-18. The original tank was improved and the light tank introduced.

At this point the experience of the Great War crystallized into various maxims, some of which have, unfortunately, been elevated to the rank of dogma. The author takes these teachings of the War *seriatim*, and

shows how post-War progress has rendered each one of them either untrue, or at best only partially true, by reason of what has happened in :—

Third period, 1919-25. The successful search after the rapid tank, and the solution of the problem of operative mobility.

Fourth period, 1925-present day. The appearance of the One-Man Tank.

The rapid tank has placed fresh problems before the tacticians of all armies, its success having conferred that very operative mobility which in the War tanks did not possess, and which now makes certain the use of independent tank-formations for wide turning-movements and attacks in flanks and rear.

As for the One-Man Tank, "we do not know yet if it will make good, whether the English will be bold enough to introduce it. Meanwhile, in its inception, it is already a working proposition. It appears to me that it matters little whether it is introduced or not ; it is of more importance as characterizing the tendency of the present towards the most ruthless mechanization of the whole army." And again :—"The One-Man Tank will certainly be improved and must be reckoned with. It opens up immense possibilities. It will be possible to flood the battle-field with masses of the smallest rapid tanks, and thus to revolutionize warfare." In this case, the infantry of the future will be the light tanks, while the infantry of the present will become special troops, a role in which they will have been preceded by the cavalry.

Such masses of One-Man Tanks in combat will need to be accompanied by larger protective tanks, rapid and heavily armed, to drive off hostile tank-chasers and to destroy hostile One-Man Tanks. This involves the introduction of a third type—the tank-chaser.

The Heavy Tank has still to be developed, and it is precisely here that fresh tactical surprises await us.

The question of the title of the article has been answered. "To ask such a question discloses a lack of touch with reality, and an ignorance of technical progress which is out-of-place."

The Influence of the Tank and the Armoured Car on War, by Dr. Regele. This article is one long list of the changes which the tank and the armoured car will produce in armies and in warfare, from the difficulties of obtaining the necessary raw material and an increased number of technical troops, through transport troubles, shipping and railway, the necessity of specially strong bridges, road-improvement and road-maintenance, the provision of tank-obstacles and camouflage, to changes in the higher tactics.

The increased importance of technics in war is illustrated by French figures giving percentages of the various arms at different dates :—

	1812	1927
Infantry	75 ...	50
Cavalry	17	2.5
Artillery	7	26
Engineers ...	1	7.3
Air Force	—	7.2
Tanks	—	7

Equally interesting is the rise in percentage of the Engineers :—

1812	1859	1914	1915	1916	1917	1918	1927
1	1	2.9	5	5.6	6.6	7	7.3

Infantry Thoughts about Anti-tank Defence, by Lt.-Col. Kéler. Written especially for the Austrian Army, which has no experience of tanks, in order that the infantry soldier may become as well acquainted with the tank as with any other weapon he has to fight against. The author states and analyses the strong and weak points of the tank to this end. Amongst the tank's weaknesses he includes its cost, the greatest obstacle in peace to the formation of numerous, uniformly highly-developed tank units, and a factor which will lead to great differences in the number and value of the tanks of the individual Powers. It is interesting to note that a similar remark is made in the preceding article by Dr. Regele, who thinks that in the long run only the Great Powers will be able to afford to replace their tank losses.

The Tactical Use of Tanks. Extracts from *Carri d'assalto*, by Col. Versè, of the Italian Army. The original book deals with the tank in attack and defence in mobile warfare, but, as it is based on the experiences of the Great War only, it reckons with no type of tank later than the light Fiat, and hence with tank-tactics of the year 1918.

The Initial Operation Plans of the Central Powers. Field-Marshal Goiginger thinks that, without discussing the large questions of whether the Germans did rightly to move first against France, and whether they were wise in violating Belgian neutrality, Germany could have done both these things and still won the War in the first few months if the Central Powers had had unity of command, and the armies had been better distributed. The distribution, in his opinion, should have been :—

Germany—Five-sixths of all fighting troops against France, of which two-thirds in the striking right wing, one-third in the left on the defensive : one-sixth of all fighting troops against Russia, of which two-thirds in an offensive in a Southerly direction behind Warsaw, one-third on the defensive on the left of the line of the Masurian marshes.

Austria—Nine-tenths of all fighting troops against Russia, of which two-thirds in an offensive in a Northerly direction behind Warsaw, one-third on the defensive on the right : one-tenth of all fighting troops on the defensive against Serbia.

The author is aware that many people will think such questions not worth raising. From a historical point of view they are, of course, right ; but the studies which they stimulate are of value to military science.

The Red Army of the Soviet Union (concluded), by Col. Kolossowsky, formerly of the Russian General Staff.

The Territorial Militia. The Territorial Militia has had difficulties of many kinds to contend with. It is short of equipment, horses, drill-grounds, instructional apparatus, etc., and so its progress has been small. Most of its divisions cannot be regarded as first line troops.

Training of the Army. A complete set of modern instructions was issued in 1924 and 1925, embodying the experience of the Great War and of the subsequent Civil War. Much stress is laid on energetic action and the offensive spirit. The cavalry are trained more for mounted action

than in other European armies. The importance of camouflage, of night exercises and gas warfare is specially emphasized. The lack of medium and heavy artillery works disadvantageously. Tank and aircraft training are mostly confined to schools.

Agitators of experience assist the political leaders, especially where the troops are considered unreliable, owing to being insufficiently politically trained.

Equipment. Equipment has been one of the Soviet State's chief difficulties. Mainly the equipment is that of the old Imperial Army, but the following have been partially introduced:—Automatic rifles, Choche and Federoff, light Lewis-guns, heavy machine-guns, Rosenberg and Maklen; the latter semi-automatic.

The cavalry is still of the dragoon type, with lance, and has the same machine-guns as the infantry—Maxim and Colt.

The artillery has no new guns of any sort, but is trying to improve the old ones, and partially to mechanize them.

Possible Operations of the Red Army. In Europe the most likely opponent appears to be the Polish-Roumanian block. In this case the military districts first concerned would be those of Smolensk, Kharkov and Moscow. These can furnish thirty-seven Infantry Divisions and five Cavalry Corps. The main blow would probably be directed against Southern Poland, while remaining on the defensive against Roumania, behind the formidable obstacle of the Dniester. The military district of Leningrad would have to provide cover against Finland and the Baltic States. It would require considerable time to produce such troops as could be made available for the Western front from the military districts of the Volga and the North Caucasus. It is questionable whether the Trans-Caucasus district could help. In Asia, the Soviet plans are actively directed against India. The military district concerned is Turkestan, which is kept stronger than the Siberian district, and is better organized, also, as a political base for the attack. The neighbouring states are meanwhile wooed with flattery. The main force of four to five Infantry Divisions and two to two-and-a-half Cavalry Divisions is in Eastern Bokhara and in the area Tashkend-Khokan. At present the country itself is not yet tranquil. In accordance with the situation in China and the new relations to Japan, the Siberian district has become more a reserve to the Central Asiatic district. Its centre has been moved westwards from Irkutsk to Novo-Nikolaievsk (now called Novo-Sibirsk). The traditional policy of Imperial Russia to gain the ice-free Pacific has turned now against Central and Southern Asia, to start the world-revolution there.

Conclusions about the Red Army. There is a widespread belief, fostered by Moscow, that the Soviet Army is weak only in material, but a powerful weapon in other respects. The opinion of the author is otherwise. There are signs that, in the matter of material, improvement is likely, but, meanwhile, he considers that the Red Army, which has made good progress in organization, is chiefly suitable for an East European theatre, *i.e.*, for a country where its mobility and large numbers of cavalry would find

full scope, and its lack of heavy artillery and technical troops would be less felt; but this only as long as Russia itself does not think of an extended offensive.

The Higher Command appears to be too optimistic about the chances of such an offensive, for which the army is hardly fitted. The use of political weapons is also reckoned upon, but these will only be effective against an opponent who is politically diseased, a condition which, in the author's opinion, cannot be attributed to any democratic nation in Europe. The campaign against Poland in 1920 furnished an instructive example, for the Polish working-men turned out as strong Nationalists, opposing the world-revolution, while the Red soldiers themselves displayed an apparently grotesque national spirit after the loss of Kiev.

The "Red Peril" will show great strength only if Russia is attacked. If Russia is the attacker, its fate is not likely to be more fortunate than in 1920.

Field Fortification after the Great War (concluded), by Col. Schneck. In future wars we (the Austrians) will strive more than ever to keep to mobile warfare, so as to avoid the degeneration which is produced by warfare of positions; but even in mobile warfare one will often be forced on to the defensive, if only temporarily. The continuous lines and complicated defence of position-warfare have been abandoned. "Only what can be withdrawn from observation, ground or air, can stand."

Nowadays, a fortified position in the field consists initially of a system of irregularly-situated nests of different weapons (light m.g's, groups of rifles, heavy m.g's, trench mortars, or field-guns) in great depth and mutually flanking, adapted to the terrain and carefully hidden. The foremost edge of the position is called the Main Battle Line; and it is before this, at latest, that the enemy must be made to break down under the fire of all weapons, since this line at the end of the fight must remain in the possession of the defender. The position of the Main Battle Line is fixed entirely by the position of the Artillery O.P.'s, lying in front of them at a suitable distance.

The chief requirements of a defensive position are wide and protected observation of the ground by the artillery, sufficient fire-effect for the infantry, the greatest possible command for the heavy m.g's, which form the backbone of the position, and protection against tanks, as much as possible, through natural obstacles.

"It is an essential of the defence that the attack must be broken down by the fire of all weapons in front of the position."

Parties of the enemy who may have penetrated, and cannot be dealt with by flanking fire and by counter attack on the part of the garrisons, must be thrown out again by immediate and powerful counter-attacks by the sector reserves, who are kept close at hand, or in prearranged counter-attack with the assistance of tanks and artillery.

The lay-out and the nature of the defence will differ according to whether the position is taken up before touch with the enemy is gained, in advance, in retirement, or after an unsuccessful attack.

The methods of fortification have naturally changed, but the principle has remained that fire-effect takes precedence of cover. In its first stage, the fire position consists only of rifle pits. These are, later, joined up by

shallow communication trenches. Heavy m.g's must be sited inconspicuously and fire invariably over parapets, often using indirect fire. Safe O.P's and safe communications are most important for the artillery. Batteries and T.M's are to be hidden by alternative positions and by camouflage. Shelters and dug-outs are to be kept small and no more than splinter and weather-proof. In field fortification there can be no question of shell-proof dug-outs. Water obstacles and inundations have gained enormously in importance, owing to their affording sure protection against tanks. Artificial obstacles will be confined to wire, placed inclined to the front and under m.g. fire. As time and circumstances permit, the defence will be strengthened more and more; C.T's will gradually be made between the nests and to the rear.

Villages and woods require special treatment. Villages are generally included in the position, but are not usually strongly occupied. The Main Battle Line will generally be in front of the village, but in the case of a large village it may often, for tactical reasons, be drawn through the centre of it. Towns are best avoided.

In a word, defence is easier than attack, and this advantage increases with the time available for preparation. The Main Battle Line here also depends upon the position of the artillery O.P's. If it is necessary to locate these along the front edge of the wood, the Main Battle Line must lie out in front of the wood. For a defence of some duration this is a good position, providing, as it does, covered approach from the rear, concealment for the bringing up or transfer of reserves, and for the attacker a depth-zone which it is difficult to traverse. When the defender is weak in aircraft, tank-defence and artillery it will be necessary to select the position running through the wood. The Main Battle Line is then more or less unknown to the enemy. The most necessary field-of-fire must in this case be cleared and the position must be protected by stout obstacles. The requisite organization of the artillery defence is of great importance.

When a decision cannot be brought about by mobile warfare, there may develop out of fortified field-positions, during a pause in the operations, more permanent positions. The foremost position is the first to be improved; C.T.'s are now indispensable, but to camouflage them is very difficult. To make the identification by the enemy's aeroplanes of the occupied portions more difficult, a number of irregular, continuous trenches, about 200 yards apart, will be dug, into which defensible C.T.'s lead from the rear.

Immediately after the improvement of the foremost position is started, the provision of positions in rear is to be taken in hand. These rear defensive systems serve the movable defence of the battle-field. They should be at least three miles apart in order to force upon the enemy the movement of his artillery.

The provision and defence of positions in the field make heavy claims upon the troops, to which they will only be equal if they have been thoroughly trained under difficult conditions and at night. Camouflage and the use of entrenching tools now form part of the tactical training of the fighting arms, who must be prepared to carry out everything for themselves, since the few technical troops available can only be allotted in exceptional cases.

Industrial Preparation for War and Mobilization, by Field-Marshal Gerabck. If a certain amount of exaggeration is pardoned, it may be said that the Great War was brought about by politicians, great industrialists and newspaper-writers, and that it was fought out by civilians, while the part played by the professional soldier was to bear all the responsibility. Of recent years the Great War must therefore be judged more by the standards of the American Civil War than by those of the Franco-Prussian War. Since with civilian armies in the Great War the morale of professional armies was lacking, it was natural in a material age to try to make up for this deficiency by technical means, and the utmost efforts were directed upon armaments and equipment. The provision of such by the General Staffs in their mobilization plans had allowed for a war lasting months only. When the war solidified to position-warfare, the German Army lost the advantage it possessed in leadership, in training, and in morale, because the war then became a matter of technics. On both sides the countries, with all their resources, became gradually organized for war on the grand scale between nations. A vast amount of experience was thus gained, and the various nations have now determined to utilize this experience by preparing in peace-time their economic organization for war just as carefully as they have hitherto prepared their military organization. This is now done under the title of Industrial Mobilization. It took about two years during the war before the transformation of industry could be completed. By preparation in peace it is hoped now to complete such a transformation in a few months.

To show what can be done in this respect the article then describes the preparations for Industrial Mobilization in two countries, where the conditions are widely different, viz., France, a military power with small population and relatively small resources, and the U.S.A., an industrial power with a small army, but almost inexhaustible resources.

The Problems of Permanent Fortification and their Solution, Review of a book by Gen. Gasca, Italian Engineers.

PART I.—The history of fortification in connection with the history of weapons: Vauban, and the *Traité des sièges et de l'attaque des places*: French fortresses after 1871; Brialmont: Sauer's system: the Rocchi type.

PART II.—The authors of the post-war period: Bernhardi, who thinks that long-range artillery and aerial bombing have put an end to permanent fortification. The author maintains on the other hand that the Belgian fortresses, if defended by the Germans or by the French, would have had another fate, and that fortresses must be armed with artillery as good as that of the attacker. He awards first place amongst post-war writers on permanent fortification to Conrad, whose solid and practical ideas might serve as a guiding line for the future. His only criticism of Conrad is that he does not draw a sufficient line between permanent and field fortification. He quotes Gurko, that the failure of many Russian fortresses had nothing to do with the principle of fortifications and their value, and that Ivangorod and Ossowietz, which were well defended, answered requirements.

After introducing Mangin, Lebas and Normand, and also a number of Italian writers in support of these views, the author comes to the conclusion that the time of permanent fortification has not passed, and that the events of the Great War did not decide against it. Fortresses only suffered the fate of all weapons that do not come up to the mark, and that is nothing new in war.

PART III discusses the type of the future. Terrain and local circumstances must be decisive, but in general the characteristics will be a fairly large area over which according to the terrain the essential elements of the work are distributed (or, when suitable, combined), connected with each other in any case by roads and telephones, etc., guns in concrete emplacements, so that every part of the work can function by itself, and also in combination with the others. Each element will then be able to illustrate in itself the ancient principle of opposing to artillery effect the appropriate resistance of material. A continuous obstacle, hidden from the enemy, raked by one's own fire and well illuminated.

The book ends with considerations on the defence of countries. There is no change in the underlying principles. Belgium only showed that the arrangements for the permanent defence of a state must be in close connection with the nation's striking power.

(*May-June, 1927*).—*Transport in War*, by Gen. Ratzenhofer. For the successful working of railways in war the author adopts a formula from the old Austro-Hungarian Service Regulations. "Strength lies in the ordered and harmonious co-operation of all." Although the Austro-Hungarian railways, partly State-run and partly private, functioned in the Great War at first exactly as had been arranged in peace, they ceased to meet requirements later under the army's changing needs and alterations forced by enemy action. In peace-time, all rushes of traffic, such as occur in the holiday season, etc., can be foreseen and allowed for; in war-time, the railways must work from case to case in unbroken improvisation. A central administration in war is, therefore, essential if all forces are to be utilized.

A number of examples from the Great War are then taken by the author to show the different sorts of difficulties which have to be met.

(1) A mounted unit is entraining by night. It arrives at the yard with more horses than the Staff had notified. The extra horse-trucks necessary are taken from the next train waiting, which thereby becomes incomplete. Results:—Troop-train is late starting, subsequent trains are affected and all junction lines; in general, increase of work and diminished performance.

(2) A division is ordered from Krakan in 1914 to take part in a turning movement against the Russians. Sixty trains are marshalled at the nearest station of sufficient size, Oderberg, and sent up to Krakan in the order asked for. The move of the division in question is countermanded and another division is ordered to go instead. The division has different strengths and requires a different time-table. The whole sixty trains have to go back to Oderberg and be re-marshalled there, taking twenty-four hours.

(3) A provisional de-training station on a new line behind the Isonzo front in 1917—a sea of mud, cold rain and wind. Maximum performance of railways is necessary owing to a forthcoming offensive. A train of forty-six trucks blocks the platform for three hours owing to one unloaded truck in the middle; contents, a groom and two horses. The groom says he was ordered by the General not to get the saddlery wet. A train containing a battery is waiting to come in and unload. After three hours a man is found to eject the groom by force. Great dissatisfaction is caused to the Staff by only seven trains being unloaded in the day instead of eight, the eighth train containing much-needed ammunition.

(4) Misplaced care for man, horse and material can upset the traffic of whole sections of the railway. At the beginning of the war, whole detachments of cavalry refused to detrain on account of bad weather, darkness and lack of other accommodation. In Transylvania, German N.C.O's refused to detrain, and the railway officials, speaking only Hungarian, could do nothing with them.

(5) The German Chief of Railways wanted to save paying for Austrian wagons when used on German trains. His order that captured Belgian wagons were to be used instead of Austrian wagons reached a German Railway Company working behind the advance into Roumania, in 1918. In order to comply with the order this company bribed the shunters to pick out all the Belgian wagons for them; result, dislocation and delay, especially as regards the sending up of the parts of an urgently required railway bridge.

(6) In the Carpathians, in the winter of 1914-15, the troops stole the lubricating grease for the wagons to grease their boots. Numerous overheated bearings resulted.

(7) In the summer of 1918, there was a great lack of covered goods-trucks. At the same time hundreds of railway employees, military guards, etc., were living in railway wagons. The strictest orders for the evacuation of these wagons, so as to get them again into use for traffic, foundered on the passivity of numbers of people who ought to have co-operated.

(8) A railway bridge has been destroyed by the enemy, and a company of engineers is sent up by train to replace it. The O.C. Company, by personal visit to the traffic office, revolver in hand, obtains preferential treatment for his train out of a number that are waiting. When he gets to the neighbourhood of the bridge he finds the enemy still in occupation, so that work cannot start. He has, therefore, unnecessarily upset the work of rail-head, where his train, 500 yards long, is now blocking those who ought to be unloading.

(9) In Transylvania, in 1916, civilians in flight cannot understand the order that they are not allowed on empty trains returning from the front. They fill the stations and storm the trains. Some of them, being influential, even manage to get exceptions made in their favour. Troops are consequently delayed in getting to the front; the front is weakened by their non-arrival; the enemy

makes greater progress and more of the civil population are driven from their homes.

(11) A German Division, in the autumn of 1916, is being transferred from the French front to join Mackensen's Army in Bulgaria, travelling via Salzburg and Graz. When the head of the division has reached Marburg, and twenty-four trains are already on Austrian soil, the destination is changed to Budapest, *i.e.*, due East instead of South-East, "further directions to follow." The railway authorities effect this change, and further directions are received "via Szolnok and Arad, to join Falkenhayn's Army in Transylvania." Twenty-four hours later, while the tail of the column is still in Bavaria, but ten trains have already left Budapest for Arad, there arrives another order "to the 3rd Army, near Stanislau, in Galicia." This order involved a change of direction of 90°, but it also was carried out, with a strain upon railway personnel and a dislocation of other traffic which must be left to the imagination.

(10) Possession is taken of an evacuated stretch of country. Railway Companies come up to put the railways in working order. Railhead must be pushed up closer to the front. All depots, A.S.C., medical, technical stores, ammunition, etc., want to get forward without respect to whether the station can meet their requirements. Before traffic arrangements have been made the staff for getting the station working is flooded out by wounded and furlough-men. It is decided to extend the station accommodation. The immediate effect of this, when workmen and materials arrive, is to increase the congestion; for traffic and construction are ever enemies. Many delays occur. As the station is not functioning properly, trains arrive without notification of nature of contents, or destination. After some days, or weeks, communications begin to work better, depots have settled down, the improvements in the station show their effect in increased traffic, and hence work in front also progresses. The front moves on, the station becomes empty and the new buildings are wasted.

(11) The article ends with a list of over a dozen different kinds of train-loads and with the question, "Where was the authority, sufficiently acquainted with all circumstances, able to determine their relative importance?"

F.A.I.

CORRESPONDENCE.

POPULAR HANDBOOK ON TIDES.

To the Editor, *R.E. Journal.*

Sir,

Whilst thanking the learned Professor for his commendation in the earlier part of his review of my Tidal Handbook, I would crave space to reply to his criticisms. I left out the effect of inertia as unnecessary in a popular description and because it seemed to have so little effect, that on

A COLONIAL SURVEY SECTION, R.E., IN MALAYA, 1923-26.