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COOPER'S HILL WAR MEMORIAL PRIZE ESSAY, 1926.

SUBJECT : THE EFFECT OF MECHANICALIZATION OF THE ARMY ON THE ORGANIZATION AND EMPLOYMENT OF DIVISIONAL AND CORPS ENGINEERS IN THE FIELD.

By CAPTAIN H. P. W. HUTSON, D.S.O., O.B.E., M.C., R.E.

MOTTO.

"They sends us along where the roads are, but
mostly we goes where they ain't!"

(SCREW-GUNS—Rudyard Kipling.)

INTRODUCTORY.

WAR AND MECHANICALIZATION.

WAR is War. Though its outward forms alter its principles remain the same. They are the foundations upon which we build the superstructure of tactical methods. These change constantly as new ideas and weapons replace obsolete ones. But the fresh methods are designed to achieve the same purposes as the old. They differ not in their aims but in their effectiveness.

The true purpose of an army is ability to deliver the maximum blow in the minimum time and with the least possible loss. To achieve this end its various components are organized and equipped with a view to the greatest output of military energy by the force as a whole. The science of warfare progresses just as other sciences do. Hence the standard of this output is a constantly rising one. Mechanicalization, in the generally-accepted military meaning of the term and in the sense in which it is proposed to treat it in this paper, represents the latest step towards improving the efficiency of an army by increasing its mobility.

We are concerned in this essay with the effect of mechanicalization upon the engineers. But the discussion cannot be confined to this one arm. It requires treatment on much broader lines. Engineers form a part only of the military machine, which is designed to operate as a whole. Mechanicalization is a means to an end and is not an end in itself. It is being introduced into the army for a definite purpose—to increase the latter's fighting value. Consequently, the army will adopt it only so far as it furthers this object. If then, we are to gauge the influence of mechanicalization upon the engineers, it is clear that we must form some idea first as to how far its introduction into the army is likely to proceed. And to enable us to judge what steps are necessary to meet the new conditions

involved it is essential that we understand the principles which govern the employment of engineers in the field.

These two points, therefore—the probable course of mechanicalization and the function of engineers with an army—will be considered now before we attempt a more detailed treatment of our subject.

THE PROCESS OF MECHANICALIZING THE ARMY.

Inevitability of the change.—The British Expeditionary Force entered the Great War equipped with a small proportion of lorries, some touring cars and a few motor bicycles. By the autumn of 1918 our troops possessed no less than 118,000 petrol-driven vehicles. Mechanicalization in the form of tanks, lorries and motor 'buses had been called upon to improve the mobility of the army. The cessation of hostilities brought the usual period of retrenchment. Mechanicalization, in common with other processes applicable to warfare, was slowed down. But there can be no question of its stopping. Movement in all its forms is the crucial problem of the day, and mechanicalization is the solution that science offers us. The reorganization of the army on a mechanical basis, therefore, is generally accepted as inevitable.

Efficiency must not suffer during the process.—Yet, whilst there can be few persons who do not see the necessity for mechanicalizing the army, a considerable difference of opinion exists as to how this is to be done. In particular, very different views are held concerning the rate at which the transformation should take place.

However much we dislike the prospect of another war, the contingency is one that has to be faced. France is still fighting in Morocco and Palestine, and there were times during the Chanak affair and the Mosul boundary dispute when war seemed rather more of a probability than a possibility for our own country. So long as universal disarmament remains beyond the pale of practical politics it is obvious that we must be prepared for war.

Mechanicalization, using the word in its widest sense to include both weapons and means of movement, has lessened the time for such preparation. Once hostilities have been decided upon, the onset may be made with a rapidity and power hitherto unknown. The importance of seizing the initiative at the beginning of a campaign has become, therefore, more vital than ever. This means that such forces as we maintain must be kept in constant readiness for war. Hence we cannot risk being caught in the process of a change. Our mechanicalization must be carried out in such a manner that the fighting efficiency of the army is at no time impaired.

Dangers of too rapid Mechanicalization.—Continuous efficiency then, is an essential of any scheme for mechanicalization, whether it entails as rapid a progress as possible, or proceeds step by step, trying out each move before advancing further Subject to this

proviso, however, the choice of policy is clearly open to argument. Those who urge a rapid transformation look mainly to the experiences of the Great War, envisaging campaigns in developed rather than in undeveloped countries. Their object is a major war against an opponent organized similarly to themselves. From this standpoint there is much to be said for their claim. But there are other factors to be taken into account. We cannot ignore the financial side of the problem. Wholesale mechanicalization would entail an initial expenditure quite out of the question in the present depleted state of the country's exchequer. Again, although progress in the design of mechanical vehicles has advanced rapidly, we are still far from being able to state that any of the existing types fully satisfy military requirements. Perhaps it is not too much to say that the army has yet to decide exactly what it wants. Under such conditions a too rapid mechanicalization might not only lead to a great waste of public money, but would conceivably leave the army inferior to an enemy who had waited to adopt a later type of vehicle. Finally, it must not be forgotten that, although our training is directed ostensibly towards a major war, we are equally likely to find ourselves engaged in an expedition against a semi-civilised people or in a terrain unsuited for mechanical vehicles as we know them to-day. It would be unsound, therefore, to mechanicalize the whole army until either the conduct of small wars and Imperial police duties had been otherwise provided for, or until a form of mechanicalization had been evolved adapted to such operations. We may conclude in consequence that any wholesale and rapid mechanicalization of the army is impracticable, at any rate at the present.

Equally essential not to lag behind.—Nevertheless, whilst we regard a too rapid transformation as folly, undervaluation of the potentialities of mechanicalization is equally dangerous. The late war furnished an inkling of what it might achieve, and at least one great continental power has taken the lesson to heart. We cannot afford to lag behind. Mechanicalization is not a process to be carried out at a moment's notice. It involves considerable dependence upon factories and, consequently, close co-operation with and organization of industrial resources. Hasty improvisation at the eleventh hour is impossible. To attempt it is to run the risk of being surprised, and surprise in material and organization is the most far-reaching of all.

Judicious progress needed.—Plans for mechanicalization, therefore, must steer a judicious middle course. There ought to be no sweeping change until we are certain that it will be for the good, and that the scrapping of the old organization and the substitution of a new one will bring greater fighting efficiency. At the same time every possible effort must be made by research and experiment to discover and try out new designs and processes. Whilst recognising the

inevitability of gradualness we should look ahead and work to a definite policy.

Probable Stages.—Mechanicalization, then, as the writer sees it, will be a process of gradual evolution. It will not necessarily proceed at a uniform rate, since this may be slowed by a period of financial stringency or during an era particularly free from warlike rumours, just as it may be quickened under converse conditions.

But it will probably pass through the following stages:—

(1) Improvised mechanicalization. . . . . During this period the aim will be to increase the fighting efficiency of the army by substituting mechanical for existing means of transport. Changes other than minor ones in its organization will not be made and the principle dominating the substitution will be the maximum utilization of commercial vehicles and the avoidance as far as possible of specialized types.

(2) Partial mechanicalization. . . . . In this stage, in addition to its general mechanicalization as above, a portion of the army will be transformed into a definitely mechanicalized force equipped with such vehicles, commercial or specialised, as are most suited to its purpose.

(3) Full mechanicalization. . . . . This is the final step, when the whole army, and not merely a part, is completely mechanicalised.

THE FUNCTION OF ENGINEERS IN THE ARMY.

Auxiliaries to the Fighting Troops.—Engineering has played a part in warfare throughout all ages. In the everlasting struggle between the might of the offence and the strength of the defence it has been employed to add power to the one or to increase the value of the other. Thus the Gauls, opposing Cæsar in the forest-covered tracts of Europe, found shelter behind timber ramparts, and the Romans, in reply, devised the testudo, advancing under cover of their shields to mine or set alight the barricades. Such was military engineering in its beginning, a valuable adjunct to the fighting soldier even in those early days, but none the less, his auxiliary. In the last resort the Gaul could fight in the open and the Roman without his shield.

Need for a Specialist Corps.—The position remains essentially unchanged to-day, though methods of warfare have altered enormously. The fighting soldier has long ago ceased to be his own engineer. So complex did the military machine become with the march of science that its engineering side soon passed beyond the reach of the ordinary soldier. It was quite impossible that he should be proficient in the use of his own weapons and at the same time master the problems of the Sapper. Armies *en masse*, therefore, ceased 'to labour at the approaches, the earthworks, the walls of

contravallation, at the same time that they attacked the enemy and defended themselves.' (1). Engineering duties became the function of a special corps.

The need for experts in this part of warfare had been recognised as far back as the time of William the Conqueror. There were men in his reign who evidently devoted the bulk of their time to the subject, and who were employed to supervise the construction of the more important works of defence and the larger engines of destruction. It was only a short step to the raising of skilled personnel for actual execution of such tasks, and from the thirteenth century onwards every expedition that set forth included its artisans for the building and repair of fortified places and for roadmaking. With the general adoption of wheeled transport arose the need for better roads and stronger bridges, whilst the increasingly destructive effect of projectiles kept calling for greater elaboration of defences. This led to a clear demarcation between the roles of the soldier and the engineer. By the time of James I, armies took the field accompanied by trains, the engineer portion of which were the forerunners of the modern corps and divisional companies.

Mechanicalization alters methods, not principles of employment.—Thus we see that field engineers came into being to meet the needs of armies in the execution of those works for which the fighting soldiers were not trained. As laid down in our regulations to-day their role is to undertake 'all temporary field engineering work necessitating skilled labour which divisions, etc., require to enable them to fulfil their function as a fighting force.'(2) To all intents and purposes, therefore, the duties of the engineers remain as they were in the past, and this in spite of the fact that new weapons and altered methods of fighting have changed the conduct of operations almost beyond recognition. We are justified in assuming, therefore, that engineers will continue to act as auxiliaries to the fighting soldiers 'to further tactical operations in progress or in contemplation.' (3)

Mechanicalization cannot alter this fundamental principle. But it will change the methods by which they carry out their duties and, consequently, may necessitate modifications in their organization. Hence in examining the effect of mechanicalization upon the engineers, we must bear in mind that they exist for the army and not *vice versa*. The guiding factor then, in adapting mechanicalization to their needs, should be increased efficiency of co-operation with the rest of the army.

We have assumed above that mechanicalization will take place in three stages, but there can, of course, be no hard and fast line

(1). "Military Architecture of the Middle Ages" (MacDermott) p. 18.

(2). F.S.R. II. 17 (1).

(3). F.S.R. II. 17 (3).

between any of these. The army has already entered upon the first, and at the same time is experimenting with a view to the second. Overlapping must occur. Nevertheless, for convenience of discussion it is proposed to treat the phases separately. The experiences of the Great War and the results of subsequent exercises and trials provide material for consideration of the first stage. There are less data for the second, and we shall have to rely upon conjecture based on the latest mechanical developments. These two periods, however, represent practical politics so far as the present generation is concerned, and will, therefore, be dealt with in some detail. The third and final stage is largely a matter of speculation, calling for the vision of those mechanical clairvoyants whom Colonel Fuller sees composing the General Staff of future armies. It is not proposed to deal at length with this phase, and conjecture will be confined to such developments as are indicated by recent scientific research.

In discussing each stage we shall consider first mechanicalization and the army, to show its probable course and the influences it may be expected to have upon warfare. We shall then examine the position of the engineers under the new conditions and see what changes may be necessary to meet them.

1. THE FIRST STAGE—IMPROVISED MECHANICALIZATION

IMPROVISED MECHANICALIZATION AND THE ARMY.

Beginning of Mechanicalization.—The mechanical era as applied to warfare may fairly be said to have seen its birth in the Great War. Not that this was the first time that mechanical devices were employed as an aid to fighting. Far from it. The horse-drawn chariot of the Assyrians at Lagash, 3000 years B.C., has been hailed as the prototype of the modern tank (1) and it is said that the Persian king Artaxerxes, fighting his rebellious brother at Cunaxa, adopted what were virtually tank tactics with his scythe-armed chariots.(2) The catapults of the tenth century and the culverins of the sixteenth were as much mechanical products of their age as the 15-inch howitzer is of modern times. But to describe these early efforts as mechanicalization is going too far, and weapons, mechanical devices though they are undoubtedly, do not fall within the term as we are considering it here. It is mechanicalization as it effects movements that we have to deal with now. And prior to 1914 armies marched or rode into battle, and their supplies and munitions were carried by horse-drawn vehicles. There have been railways, of course, for nearly a century, available for strategic moves, and to a limited extent, for tactical ones. But their real function has been to maintain a force from its base, and we may say that the army continued to carry itself into the fight.

(1). "Tanks in the Great War" (Fuller), p. 300.
(2). "Warfare" (Spaulding), p. 68.

It did so in 1500 B.C., when Thotmes III, marching rapidly from Zalu, on what is now the Suez Canal, across the desert, reached Gaza, a distance of 160 miles in twelve days.(3) And again in the Mons to Marne retreat, when five divisions and one cavalry division covered 200 miles in thirteen days. Evidently mobility has not kept pace with other improvements in war. So long as man and horse supplied the motive power the speed of an army was limited to approximately fifteen miles a day. It was the advent, in 1914, of the petrol-driven vehicle to the battlefield that made greater mobility possible.

Progress during the Great War.—The enormous increase that took place during the four years 1914-1918 in the number of motor vehicles with the forces in France is largely attributable to the fact that operations were being carried on in a country well equipped with roads, and to the absolute necessity for relieving congestion on the railways. But, although mechanical transport was used extensively, its advantages were never exploited to the full. Incidents such as Gallieni's taxicab reinforcement of Maunoury, when he was engaged with Von Kluck in September, 1914, the transport of infantry in lorries to support the mounted troops during the "Race to the Sea" in the same year, and the move of the First American Army, 400,000 strong, in six nights from the St. Mihiel region to the Argonne, in September, 1918, showed something of its potential value. And the arrival of the tank, the armoured cross-country vehicle created as the answer to machine gun nests, trenches and barbed wire, opened a still larger vista of possibilities. The middle of a campaign, however, is no season for far-reaching changes in organization and equipment. So the problem of mechanicalization was left for solution after the war.

Problem confronting the Army to-day.—Two factors are contained in the problem that now faces us—fire-power and movement. The Great War brought a considerable measure of achievement of the first, and despite the fact, or possibly because of it, that during some three-and-a-half years its fighting was mainly of a static nature, it impressed upon us the need for the second. The essence of its teachings was that a force should be both hard-hitting and fast-moving. Fire-power and movement had to be combined. Either one without the other was valueless. The efficient combination of these two factors, then, is the problem before the army. The mechanically-propelled vehicle provides the means, and the experiences of the Great War give a clue as to the way.

Of the nations who took part in that struggle France, perhaps, has made the greatest subsequent progress in mechanicalization. This is mainly due to her military position with reference to Germany. Attack across the frontier by this neighbour is a

(3). "Warfare" (Spaulding), p. 11.

contingency against which France must be secured. Provision to meet it surpasses in importance all her other military problems. Her energies and resources are principally directed, therefore, to guarding against a single definite emergency. The solution which seems to be in favour at the moment is to forestall the hostile blow by striking hard and fast across the frontier. The French advanced troops must be able to move forward and seize points which would make the industrial preparation of the enemy difficult, if not impossible. Great mobility and fire-power will be necessary to thus carry the war rapidly into their adversary's territory and secure an early decision rather than a success after a prolonged struggle. France is therefore exploiting mechanicalization to the full, taking advantage of the fact that the country of the opponent against whom her schemes are directed is suited to mechanical movement.

Our military position is more complicated than that of a continental Power. British commitments are world-wide, and a major war under European conditions is only one of the many contingencies to be met. It is possible that the danger of aerial attack on the British Isles may ultimately dwarf all other issues by its urgency, but, for the present, defence against this menace is a matter which concerns, primarily, the air force. So the organization of the army must still be based, as has been the case for some considerable time, upon average conditions, though capable of modification to meet exceptional circumstances. In the latter category we may include a major war under European conditions. Consequently, whilst such a case may conceivably call for large permanent mechanical forces as the most efficient type of army, we cannot accept it as the controlling factor in military reorganization at the moment.

The mechanical vehicle adapted to all, or even to most, of the conditions under which British troops may be expected to fight has not yet been produced. Until this has been done mechanicalization of the whole, and probably of the bulk, of the army is out of the question.

The existing divisional organization has been evolved to meet average conditions. It is accepted as the most suitable for the purpose, and, until the progress of warfare shows that there is a better alternative, it will form the most satisfactory basis for any scheme of mechanicalization. There can be no question of putting the whole of the division into vehicles at once. Eventually this may be done, but not at first. Not only would the undertaking be so vast as to prove impracticable, but it has yet to be decided that everyone is needed in vehicles. For the moment the problem is rather how to gradually substitute mechanical transport for men and horses so as to increase the mobility of the division without decreasing its fighting efficiency, and at the same time, where

possible, so as to effect economies, thus permitting increases in other more profitable directions. There are two ways in which the substitution may be carried out :—

(a) division by division, completing each one before another is commenced ;

(b) working on all divisions simultaneously.

The ultimate result will be the same with either method, but the former is perhaps the sounder and, therefore, the more likely one to be adopted.

Mechanicalizing the Division.—It is not intended to discuss the mechanicalization of the division in any detail. All that is wanted is a general idea of the lines the process is likely to take.

The choice of the type or types of vehicle will be the first matter for consideration. Track or semi-track transport will be adopted eventually because of its ability to move across country. But, for the present, reliance must be placed upon existing resources rather upon visions of the future. It is more than doubtful whether a sufficient supply of these specialised vehicles would be forthcoming readily. They have not been adopted very largely in commercial life as yet. The question of reserves to replace losses would be difficult, and in the event of a major war it would be quite impossible to meet the army's requirements. Even if conditions were otherwise, and adequate provision could be made to meet casualties and to cope with expansion, the high initial cost of any scheme involving the general use of track or semi-track vehicles must render it impracticable. During this, the first stage of mechanicalization then, commercial types will have to be relied upon and specialised vehicles used only where no existing type would meet the case.

Taking this utilization of commercial vehicles as the guiding principle of improvised mechanicalization we may visualize the process, so far as a division is concerned, as proceeding somewhat on these lines :—

(*a*) a general substitution of tractor-drawn vehicles for first-line transport ;

(*b*) the mechanicalization of the divisional artillery by means of tractors ;

(*c*) the gradual provision of lorries to carry at first a portion and eventually the whole of the marching personnel.

Probable changes in Tactics.—The mechanicalization thus envisaged does not put the whole army on wheels at once, nor does it provide generally for movement across country by vehicles. For some time, probably, the infantry will still have to march and, even where lorries are provided for them, the troops would debuss as a rule a considerable distance from the firing line. In spite of these limitations, however, there will be a general improvement in

mobility. Fast-moving columns, at first up to, say, brigade group strength, ultimately of whole divisions, could be formed, and would be able to operate at about six miles per hour over a radius of some hundred miles. Rapid moves from one portion of the battlefield to another, or from front to rear, at six to eight miles an hour could be made by large or small bodies of infantry supported where necessary by mechanicalised artillery, tanks and armoured cars. Mounted formations could be strengthened in fire power with no loss of mobility by the addition of "mechanicalised" formations.

The full effects of this mechanicalization must be largely a matter of conjecture. But we shall be justified in making certain assumptions as to the general characteristics of any fighting that may occur during this stage ;—

(*a*) Cavalry will still be required for reconnaissance. Their offensive power and, therefore, the scope of their activities may be increased by organizing them on the lines of the French "Divisions légères."

(*b*) Mobile columns are likely to be employed to seize places of tactical importance in advance of the rest of the force, or may be rushed up to exploit a success or close a gap. They will certainly be used in rearguard operations.

(*c*) The importance of communications to a force will be greater than ever, whilst at the same time mechanicalization has increased the means of interrupting them.

(*d*) There will be a tendency for fighting to be attracted to areas unsuited to mechanical movement. Such localities will appeal to the defence by reason of the security they offer against attack by mechanicalized columns. The attacks will be drawn towards them to forestall the enemy and so deny him the advantages they afford.

(*e*) Blows will be struck and parried at greater speed, with a relatively greater strength and over a wider area than heretofore. Phases of battle, therefore, may be expected to change more rapidly and more abruptly than in the past.

IMPROVISED MECHANICALIZATION AND THE ENGINEERS.

Engineers in 1914 *and to-day.*—Having considered the course mechanicalization is likely to take and its probable influence upon tactics, we are now in a position to study its effects upon the divisional and corps engineers. To properly gauge the changes involved by the new conditions, however, we will begin with a glance at their position in the pre-mechanical era.

The R.E. entered the 1914-1918 struggle with an organization based largely upon the teachings of the South African war. They were intended to move dismounted or mounted accordingly as they belonged to an infantry or a cavalry division. Their chief duties were to provide for the passage of these troops with their transport

across rivers, streams and other obstacles, to render difficult by demolition or otherwise the movement of the enemy, to carry out such works as were necessary to strengthen positions to be held, or to destroy by mining those of the foe, and to arrange such temporary accommodation, water supply services, etc., as might be needed. This was a formidable array of tasks, and there were others which there is no space to detail.

To carry them out there were at first only two field companies per division. It was not long before this number had to be increased by the addition of a third company. But even so the engineering personnel proved inadequate, and pioneer battalions were organized to supplement them. However, the vastly increased firepower of the contending armies, combined with the generally intensive nature of the fighting, so increased the quantity of field works required, and widened their scope to such an extent, that it became clear that the major portion of at any rate the front line work would have to be undertaken by the infantry. The numbers of engineers were sufficient only for those tasks which demanded technical skill, special tools, or particularly elaborate organization in connection with the main zone or rear defences in position warfare.

Besides the question of field works there was the problem of bridging. Each field company carried enough pontoons and trestles to construct 75 feet of medium bridge. The bridging train, which was an army unit, had material for 250 yards of medium, or 125 yards of heavy, bridge. This so-called heavy bridge would carry such mechanical transport as the expeditionary force was equipped with at first, but was far too weak for the loads that arrived subsequently. In October, 1914, there was the eight-inch howitzer weighing thirteen tons on one axle. It was followed shortly by by the six-inch Mark VII gun on a naval mounting with a maximum axle load of seventeen tons, and during 1917 the introduction of tanks brought the weight to be carried up to thirty tons. Loads such as these demanded special bridging material. The army possessed neither the equipment nor the personnel trained in its use. A good deal of rapid railway bridging had been done in South Africa, but under very different conditions, and heavy timber and trestle bridging, in which the engineers received some training in peace, was too slow a method for modern conditions. Though the need for heavy bridging first arose on the Aisne, there was comparatively little of this work necessary during the subsequent period of static warfare. This gave time for steel spans to be obtained and for a certain amount of training to be given in their erection. From 1917 onwards, bridging became of great importance, and the power of the British Army to advance depended largely on the speed with which its engineers could construct bridge crossings. The field companies erected temporary crossings for the infantry in the

first instance, and followed these with medium bridges for their first line transport. Then the heavy bridges were put up, mainly by fortress companies which had been converted into army troops companies and equipped with special plant and mechanical transport for the purpose. A most noticeable point was the short interval of time after the first temporary crossing before the heavy bridge was wanted.

After the war the divisional engineers were reorganized as they stand today, *i.e.*:—

H.Q.
Field Park Company
3 Field Companies

There are no corps engineers shewn as such in the new war establishments (1) but they would presumably be found by the allotment of one or more of the non-divisional units, possibly an army troops company and a bridging park. The field companies do not differ greatly from those of 1914. They are slightly stronger in personnel, and some minor changes have been made in their transport, but generally speaking, they remain much as they were except, of course, for the fact that they now carry no bridging material. During the war most of the companies dumped their pontoons and trestles in divisional or corps parks, partly because the transport of this equipment was a hindrance to them, and partly because they needed the waggons for other purposes. The withdrawal of the bridging equipment then, is merely the acceptance of what had become a recognised practice. The field park company is primarily a workship unit, existing at present in cadre form only. It is to carry two trestles and three 21-ft. bays of superstructure for a medium bridge.

The bulk of the bridging material is apparently to be concentrated in parks, presumably army units, which will be alloted to formations as circumstances demand. Broadly speaking, there are three types of bridge to be considered:—(1) assault bridges; (2) floating bridges; (3) steel bridges. The light or assault bridges carry infantry or pack. No details of their transport nor of the scale on which they are to be provided are available as yet. It is possible that they will be carried in a corps or divisional park and issued to units or formations for specific operations. A suitable scale of provision might be nine bridges, each eighty feet long, per division. As regards floating bridges, it is believed that three medium bridges, each 126 feet, and four heavy bridges of 105 feet, are to be carried in a pontoon park. Finally, there will be a bridging park for steel spans. These two last units, the latter of which already exists on paper, will be under army control, probably, and will be detached temporarily to lower formations.

(1). "Provisional War Establishments" XXVa.

Their employment under the new conditions.—The chief characteristics of warfare under the conditions of improvised mechanicalization have been dealt with in a preceding paragraph. They will affect field engineering in two ways :—

(1) By decreasing the time factor, *i.e.*, they demand work at an increased speed.

(2) By increasing the importance of communications, so that the question of their maintenance, including bridging, of course, has become the most urgent duty of the engineers.

Engineers will be required with the mobile columns, as well as with those portions of the force which have not been mechanicalized. Their duties with the former will include :—

(*a*) Passage of troops and transport, including tanks, over gaps and obstacles.

(*b*) Creation of gaps and obstacles to destroy the enemy's mobility.

(*c*) Maintenance of roads required by their own forces and destruction of those wanted by the opposing troops.

(*d*) Rapid fortification, with particular attention to the construction of obstacles to meet attack by tanks and armoured vehicles.

Engineers working with unmechanicalized formations will find their tasks much as they have been hitherto, but under conditions which demand greater rapidity of work with, at the same time, a higher degree of solidarity and strength to meet the more destructive power of modern weapons and to carry the heavier loads by which armies are now accompanied.

Changes in organization to meet these.—If the engineers are to be able to co-operate efficiently under the new conditions with the troops they are working with, they must have :—

(*a*) An organization conformable with that of the formations to which they belong, sufficiently flexible to facilitate the provision of detachments for small or dispersed tasks, and to permit concentration of effort for a work of magnitude.

(*b*) A form of transport such that personnel, tools and material can reach the site of the work in time to carry it out.

(*c*) Personnel and equipment suitable for the execution of the duties at the necessary speed and with the requisite degree of strength or elaboration.

We will examine each of these essentials separately.

Organization :—The principle of economy of force is as applicable to field engineering as it is to fighting. It implies the employment of engineers in minimum numbers until the task is disclosed, and then a rapid building up of the resources required so that the work may completed without delay. In other words, engineers, in common with the other branches of the service, have to be employed in depth.

Their organization, therefore, must be such as will permit this.

The task of divisional engineers may be a simple demolition that could be carried out by three or four sappers or, equally well, the erection of a bridge necessitating all the engineer labour available. Obviously it would be unsound to keep the engineers fully concentrated. If this were the practice they would have to move either near the head of the advance, thus being liable to serious losses before they had started their work, and, moreover, impeding the movements of the fighting troops, or in rear, from which position it might be difficult to send them forward in time to carry out their task without checking the progress of the force. Neither alternative is desirable. The efficient execution of field engineering requires a steady building up of resources without overcrowding, and a continuous flow of work towards the desired end. Put into practice, this means engineer reconnaissance parties with the advanced troops to discover requirements and to estimate resources needed, and small detachments near the heads of leading formations ready to start the work and to elaborate the reports of the reconnoitring parties. The major portions of the engineers will move further to the rear of the force, but so that they can be sent forward as and when required. Finally, there are the workshop units, bridging trains, etc., the occasions for the employment of which it will usually be possible to anticipate, so that their dispositions may be arranged accordingly.

The present organization of the divisional engineers into H.Q., Field Park Company and 3 Field Companies facilitates observance of the principle of economy of force. It is flexible enough to give the required dispersion whilst readily providing for concentration when needed. An example may make this point clearer. Take the case of a division moving with a brigade acting as advance guard. The engineers with the force could be disposed as follows :—

With the Advance Guard mounted troops, 1 officer and 3 men (reconnaisance party).

With the Vanguard mounted troops, one section Fd. Coy., R.E., (for small tasks or to start larger ones.)

With the Main Guard mounted troops, Fd. Coy., R.E. (less one section and reconnaissance party).

With the Main Body mounted troops, H.Q. Divisional Engineers, Fd. Park Coy., two Fd. Coys. R.E.

It will be noticed that the engineers have been distributed in increasing strength from front to rear of the division. Their resources are brought into play, therefore, in accordance with the magnitude of the task. A minor work involves no waste of energy or needless exposure of personnel, since the forward detachments are on the spot to deal with it. At the same time, for a heavy task the engineer-

ing strength can be built up rapidly, and each detachment, even the smallest, will make a definite contribution towards its completion.

As things are, the present organization of the divisional engineers is probably as satisfactory an arrangement as can be reached. Mechanicalization has not changed the divisional organization. No modification of that of the engineers would seem necessary, therefore, on this account.

Transport.–We will turn now to the question of the mobility of the engineers. The latter must be able to accompany the troops for whom they are working, and at the same time their transport must be arranged so that the flexibility within the unit is not diminished. The division in its state of improvised mechanicalization has been equipped with tractor-drawn artillery and transport. The infantry will still be on foot normally, though portions and, occasionally, perhaps, all of them may be moved in lorries or form part of a mobile column. Consequently the transportation scheme of the engineers must provide as a minimum for the mechanicalization of their first line transport, and for the movement by lorry of those portions or units which are acting with mobile columns.

It is a matter for consideration, however, whether the engineers should conform exactly with the infantry at this stage, or whether it would not be preferable to eliminate all marching personnel at the outset. The engineers are not primarily fighting troops. Their *raison d'être* is work, and there is small doubt but that a greater output of this can be obtained from men who are carried to their task, and so reach it comparatively fresh, than from those who have borne the fatigue of a long march before beginning their labours. Moreover, though in the past field engineering has been more closely connected with the infantry than with any other arm, this association is likely to become less marked in the future. We have seen already how practically all the front line field works have devolved on the infantry, whilst the engineers are employed on the more technical duties of bridging, demolition, and in connection with the more elaborate rearward services. It appears, too, that the infantry will have to accept chief responsibility for assault bridging. They may receive the material for this from the engineers, but the latter's most important concern will be the erection, as soon as the infantry are across the gap, of the heavier bridges for their transport.

Then there is another aspect of the question. If an advance is to continue unchecked, there must be means of pushing forward engineers to deal with the succession of obstacles that are likely to be met. With the engineers possessing a rate of movement only equal to that of the rest of the force this would have to be done by leap-frogging units from the rear over those who have stopped to work. This might be a feasible proposition when the force is operating on a narrow front. A division moving along a single road would have

four engineer units available for leapfrogging, and might reasonably count on being able to cope with the obstacles likely to be met in the course of a day's advance. But with a more extended front the engineers cannot be distributed in such depth, and leapfrogging would only be possible by mingling units from formations in rear. Such a procedure would involve complications in command, and is to be avoided if possible. A more satisfactory method would be to make the engineer units more mobile than the formations they work with. This would render it easier for them to regain their position in the advance after having been left behind to complete some task, and would facilitate their lateral movement across the front, thus compensating for the loss in depth that occurs when the frontage is wide.

For the above reasons it seems not only unnecessary but also undesirable that the method of transportation adopted by the divisional engineers should conform exactly with that used by the infantry. If the engineers are to carry out their duties and at the same time keep up with the rest of the force, their mobility must be greater than that of the latter. It appears, therefore, that engineering personnel should normally not be required to march. The mechanicalization of the engineers consequently concerns the movement of the men, as well as the technical equipment, stores, etc.

We have now to consider the choice of vehicle. The bulk of the division is still equipped with wheeled transport. Hence it is primarily dependent for movement upon roads. Work in connection with these, including bridging of course, has become in consequence the most important of the engineers' functions. Ability to move along roads at adequate speed is therefore the first essential of their transport. At the same time there are sure to be numerous occasions when the engineers have to move across country. A fast-moving cross-country vehicle such as the Dragon would give the requisite mobility, both on roads and off them. But we have ruled out the general use of specialised vehicles for the period of improvised mechanicalization, and so are limited to a decision between wheeled transport and commercial tractors, or possibly to a combination of both types. The first gives speed but not movement across country, and the second is slow. There are obvious drawbacks to the use of both types in one unit, and it will be better to adopt one or the other. The wheeled vehicle is the best for work on or near roads. The question is whether its use will prevent the engineers from preforming their cross-country duties efficiently.

The crux of the matter is the tool cart. Must this vehicle be able to move across country? The answer is in the negative if we consider a campaign in a well-developed country. There will be sufficient roads or lanes to bring the engineer vehicles as close to their work as the enemy is likely to allow. With any form of transport, movement from here would have to be on foot and the tools carried. The

disadvantages of such a procedure are not serious. As a rule, only a proportion of the contents of the tool cart will be wanted for any one task, and it is usually possible to forsee the requirements. Moreover, the heaviest single item that might be wanted in a hurry, the exploder, weighs only twenty-seven pounds, and so is quite portable. Under such conditions, therefore, the use of a wheeled vehicle as a tool cart need not impair the efficiency of the engineers. There is no necessity to take the case of fighting in undeveloped territories, since these afford small scope for the employment of a force mechanicalized, as ours is at present, with a large proportion of wheeled vehicles. It appears, therefore, that wheeled transport will answer the purpose of the divisional engineers.

As regards size of vehicle, we have roughly a choice between light lorries (30 cwt.) and heavy ones (3 tons). The divisional train is equipped in the main with the former, but the ammunition company is likely to use the latter. We have not considered the question as to which should be employed for moving infantry personnel, but it is possible that the light lorry will be selected, since it will just carry two sections, thus ensuring an economical load without breaking up units. However, there is no reason why the whole division should be equipped with the same sized lorry. Probably both the 30 cwt. and the three-ton vehicles will be used. So far as the engineers are concerned, it is a question of which of these two will prove the more suitable.

The war strength of a section of a field company, excluding the five drivers who would be replaced by M.T. personnel, is 51 all ranks. These could be carried either in three 3-ton lorries at 20 each, or in four 30 cwt. lorries at 13 apiece. The latter method wastes none of the vehicle's carrying capacity, and allows the section to be subdivided for work into four portions, each with its own transport. The total weight of tools, technical stores and baggage which are now distributed over the tool cart, two L.G.S. waggons and a pack animal is about 28 cwt. If an additional 2-3 cwt. be allowed for boxes and fittings, and the blankets and baggage be transferred to the personnel vehicles, the whole of the section's tools and technical stores would form a very suitable load for one light lorry. This type is evidently adapted to the requirements of a field company.

Personnel and Equipment.—Having dealt with organization and transport, there remains the question of efficiency as influenced by personnel and equipment. Training is beyond the scope of this essay, and it is assumed that what is required will be forthcoming. Apart from this and the policies as regards organization and transport which we have discussed above, the output of the engineers will depend upon the suitability or otherwise of their men and plant for the work required of them.

The new *War Establishments* (1) show an alteration since pre-war days in the distribution by trades of the rank and file in a field company. We may divide the tradesmen into three broad groups :—

(*a*) Mechanical trades, including smiths, electricians, engine drivers, fitters, plumbers, etc.

(*b*) Building trades, including bricklayers, carpenters, joiners, masons, painters and decorators.

(*c*) Miscellaneous trades, including clerks, draughtsmen, farriers, miners, saddlers, surveyors, wheelers, etc.

The proportions of these groups have been changed as follows :—

(*a*) Mechanical trades, nearly 25% of the tradesmen in 1914, have been increased to 42½%.

(*b*) Building trades, nearly 55% of the tradesmen in 1914, have been decreased to 45%.

(*c*) Miscellaneous trades, just over 20% of the tradesmen in 1914, have been decreased to 12½%.

This new distribution evidently recognises a larger proportion of "mechanical" work for the engineers than hitherto. We must see whether it will suffice under the conditions of improvised mechanicalization.

The effects of these are mainly in the direction of increased speed and at the same time greater solidarity. The tasks will remain generally as before, but we may expect :—

(*a*) Higher proportion of bridge construction and road maintenance.

(*b*) Greater use of steel, especially for bridging.

(*c*) More demolitions.

(*d*) Increased employment of motor-driven pumps, electric plants, etc.

(*e*) Less work on front line defences, but greater elaboration of rear systems.

(*f*) Fewer and smaller services in connection with water supply.

Evidently there will still be a demand for skilled labour of most, if not all, of the trades now included in a field company. Whether the existing proportions will remain correct it is difficult to say without further practical experience. The mechanical trades will be in full demand for a certainty. But so will the building trades. Carpenters are always useful; bricklayers and masons will be needed for work on culverts, concrete dugouts, etc. Miners, too, will be wanted for their own trade and usually provide the most suitable men for demolition work and quarrying. The writer is of oponion, therefore, that no further change in the proportion by trades should be made at present.

As regards tools, no revised field service manual for a field company has been issued since the war. So far as is known, companies

(1). Part XXIIIa.

are carrying much the same war outfit, excepting, of course, bridging material, as they did in 1914. Presumably this will be modified to meet the altered distribution of tradesmen.

The question of using mechanical plant as an aid to more speedy work has been raised of late, but it is doubtful whether much could be done with it in field companies.

Mechanical plant usually requires a permanent crew, and if introduced on any considerable scale would decrease the flexibility of the units without a commensurate gain in efficiency. The field park company is provided with a mobile workshop which includes a circular saw. This should meet the normal requirements of divisional engineers. On occasions, no doubt, petrol pile-drivers and air-compressor plants would be valuable for salving and re-erecting damaged girders, for drilling existing girders, for reinforcement, etc., but they should normally be kept in rear until required, and then sent up with their own crews. Their proper place is not with divisional troops, but with army troops companies, bridging parks and the like.

Mechanicalization of the Divisional Engineers.—We will now apply the conclusions reached above to the improvised mechanicalization of the divisional engineers. The decisions arrived at may be summarized thus :—

(*a*) No change to be made in the general organization.
(*b*) Mechanicalization to be carried out with 30 cwt. lorries.
(*c*) No further change in personnel or equipment.

Taking these as the principles upon which to found the scheme, and basing our calculations upon *Provisional War Establishments* XXIII *a* (*Small War*), we arrive at the following suggestion for the first stage of the mechanicalization of the divisional engineers :

H.Q. Divisional Engineers.

H.Q. Divisional Engineers.	Motor-car.	M/c. and sidecar.	Light lorry.	Trailer.
Cmdr., Adjt. and R.S.M.	1			
2 Orderlies..		2		
Sgt. and 8 O.Rs			1	
	1	2	1	—

Field Park Company.—This unit is already mechanicalized. The only changes necessary are the replacement of the horse-drawn water cart and travelling kitchen by vehicles which can be trailed behind the lorries, and the substitution of two motorcycles with sidecars for the two riding horses.

Field Company.

	Motor-car.	M/c. and sidecar.	Light lorry.	Trailer.
Headquarters :—				
Major, C.S.M., Trumpeter	1	—	—	—
Capt. and one O.R. ..	—	1	—	—
C.Q.M.S. and 9 O.Rs ..	—	—	1	—
Officers' Mess & 2 Batmen	—	—	1	—
Water cart	—	—	—	1
Travelling kitchen ..	—	—	—	1
Technical Stores and Baggage	—	—	1	—
	1	1	3	2
4 Sections, each.				
Subaltern and one O.R. ..	—	1	—	—
Sgt. and 12 O.Rs ..	—	—	1	—
Cpl. and 12 O.Rs ..	—	—	1	—
Cpl. and 12 O.Rs ..	—	—	1	—
Cpl. and 6 O.Rs ..	—	—	1	—
Cpl. and one O.R. ..	—	1	—	—
Tools and one O.R. ..	—	—	1	—
Technical Stores, Baggage and Cpl.	—	—	1	—
	—	2	6	—

II. THE SECOND STAGE–PARTIAL MECHANICALIZATION

PARTIAL MECHANICALIZATION AND THE ARMY.

Advance of Mechanicalization.–We have seen how in the first stage mechanicalization was largely a matter of improvisation. It is now to be carried a step further by the creation, *ab initio* if necessary, of the mechanical force most suited to our needs and resources.

The whole question of mechanicalization is still very much in the embryonic stage, and this is particularly so as regards completely mechanicalized forces. The late war furnished no instances of their employment. During subsequent peace time training there have been several exercises with temporarily formed mechanical columns, as well as a number of paper schemes involving their use. In addition, those in search of the requisite vehicle have held numerous trials and reliability tests. To a great extent the results of all these

exercises, schemes and trials have proved inconclusive, but this is a common failing of most peace exercises. Nevertheless, though it is clear that the problem of mechanicalization bristles with difficulties, there is no evidence of a diminished belief in the potential value of a mechanical force provided this can be properly constituted and is correctly handled.

The creation of one or more of these forces as permanent parts of the army seems almost a certainty. Whether this will take place shortly or in the distant future it is impossible to say. But it would not be unreasonable to assume that, with the British expeditionary force remaining at its presemt strength of some five divisions, the equivalent of one of these at least will ultimately be transformed into a mechanical force, and provision will be made for a like treatment of a proportion of the Territorial Force in the case of a major war. We will make this assumption the starting point of our discussion of partial mechanicalization, and will now consider the effect of this upon methods of fighting.

Possibilities and Effects.—An early decision is of the utmost importance in war, and if we except the air arm, the employment of which does not come within the scope of this paper, there is no force so likely to obtain it as a fast-moving hard-striking mechanicalized one. Consequently we may expect a nation that possesses a sufficiently strong force of this nature to use it vigorously at the outset of the campaign, in the hope of dealing the enemy a paralyzing blow. To consider how opportunity for such action will arise and may be taken advantage of, we will examine various types of campaign separately :—

(*a*) *A major war against a partially mechanicalized enemy in a "European" terrain.*—The side having the initiative will probably launch its mechanicalized forces at once, supporting them by strong air fleets. They would seek to defeat or evade the hostile covering troops, and then sweep down upon the unmechanicalized bodies in rear, or they might move against some vital industrial or other centre, so as to hinder the enemy's mobilization. Where the opponents are equally matched and neither can be caught unawares, the delivery of the decisive blow at the start of the campaign may not be feasible. In such a case the mechanicalized forces may operate by bounds from objective to objective, paving the way for the culminating blow. Under these conditions the rest of the army would take over and hold ground gained by the mechanical forces so as to free these for further advances.

(*b*) *A major war against a partially mechanicalized enemy in an undeveloped country.*—We may imagine such a case as this occurring where some great Power is supporting the pretensions of a minor state against another great Power, and the fighting is taking place in the territory of the minor state. It is quite possible that the nature of

the latter's country would be generally unsuitable for the employment of mechanicalized forces. How would the latter function in such an event? Let us consider the concrete, if imaginary, case of Russia supporting Afghanistan in a war with Great Britain. Against Afghanistan the Indian army could probably advance to Jalalabad and Kandahar. For further progress reinforcements would be needed from the United Kingdom or elsewhere. Whether or no these troops arrived before those that Russia would be despatching to her ally would have a most determining effect upon the course of the subsequent operations. Time in an instance such as this would be a very vital factor, therefore. It is conceivable that we should seek to gain it by delaying in some way the movement of the Russian troops from Europe. A feasible and effective means of doing so, given command of the Black Sea, might be by using a mechanicalized force to cut Russia's trans-Caspian route.

Thus, where the nature of a country is unfavourable to large scale mechanicalized operations, it is possible that whilst small mechanicalized columns only would be employed there, *e.g.*, in the above instance to move on Kabul from Kandahar say, the bulk of such forces could be used to influence the campaign by an independent mission.

(*c*) *A minor war against an unmechanicalized foe in a "European" terrain.*—In a war of this nature the chief share of the fighting is likely to fall to the mechanicalized forces. The chances of an early decisive success might well be most favourable. Even if they were not, the role of the unmechanicalized part of the army will be confined, in all probability, to the securing and holding of a base or jumping off ground for the mechanicalized force, and to taking over from it objectives gained.

(*d*) *A minor war against an unmechanicalized foe in an undeveloped country.*—This class of campaign has figured frequently in the past history of the British Army and may continue to do so. The final outcome of struggles of this type is seldom a matter of doubt. How to obtain a rapid decision has been the problem as a rule. A protracted struggle is undesirable, not only on account of its higher cost, but because it encourages waverers, who might otherwise not have taken part, to join in, and so widens the area affected. Mechanicalized forces will make for speedy results, provided that the nature of the territory permits their use. In countries such as Iraq it might be possible to rely upon them almost entirely, and success would be sought by a rapid dash to the objective. But in some parts of the world, notably on the north-west frontier of India and in the swamp and forest areas of the Sudan, conditions are so unsuited to mechanical movement, except along prepared tracks, that mechanicalized forces could scarcely be employed off these. Their role then would be a subsidiary one, limited mainly to the protection of the lines of communication.

We may conclude, therefore, that, except in some small wars in very difficult territory, there will usually be no lack of opportunities for effective action by a mechanicalized force. The next question is a consideration of the tactics it is likely to adopt to take advantage of these chances. The essence of the employment of a mechanical force must be vigorous offensive action. Full use should be made of its great mobility to surprise the enemy and shatter him before he is ready to withstand the powerful onslaught. Simplicity and dash should be the keynotes of the force's tactics. There will be little time to make plans, and reconnaisance before action must necessarily be limited. But its speed and armament will enable it to take risks which a slow-moving unmechanicalized force could not afford.

Normally the mechanicalized force will operate independently of the remainder of the army. This does not imply, however, that it needs no communications. Its mobility and its power to move across country certainly allow considerable latitude in the choice of these, but it cannot do without them altogether so long as its radius of action is not unlimited. On occasions it might be possible for the personnel of the force to live on the country. One can hardly anticipate this as regards fuel and munition supply. A base of some sort is sure to be an essential, either as a place to which the mechanicalized force can return to refit or to replenish its resources, or from which its trains may be sent up to it. Communication with this base must be assured, and so must be the safety of any trains despatched thence. So long as rivers, woods, mountainous areas, marshes and the like remain impassable to mechanical vehicles,—and as yet we cannot visualize any single conveyance capable of negotiating all these obstacles—there will be opportunities for severing the communications of the mechanicalized force. The latter's position, if it cannot regain them before its fuel supplies are exhausted, is likely to become precarious.

In attacking unmechanicalized formations the mechanicalized force will find its most favourable opportunity when its opponents can be caught on the move. If the latter are unassisted by armoured vehicles there will be every chance of overrunning them before their artillery can intervene effectively. So great, in fact, is this danger to which unmechanicalized formations are now exposed that they may be expected to move by bounds from one prepared position to another, quitting each only as they are assured that the route to the next is clear.

The dominating role in the fighting of this period then is likely to be played by the mechanicalized force. Acting as the spear head of the army, it will conduct a vigorous offensive well in advance of the unmechanicalized troops. If it cannot destroy the opposing mechanicalized columns, it may seek to evade them, and by rapid movement surprise and crush the forces in rear. The unmechanical-

ized portion of the army will further the other's operations by taking over ground captured, by holding vital defiles, bridgeheads, etc., so as to ensure its safe communications, and by occupying positions difficult of attack, and behind which the mechanicalized force can withdraw to refit.

The mechanicalized force.–We will turn now to the organization of the mechanicalized force. The starting assumption for our discussion of this period has been the mechanicalization of a force equivalent to a division. This force must be prepared, as our examination of the probable nature of the fighting has shown, to operate to a great extent independently of the rest of the army. Obviously, therefore, its organization must be a self-contained one. That is to say, it should include a proportion of fast-moving vehicles for reconnaissance, a main body of adequate striking power and sufficient speed, enough supplies and munitions to give the force the necessary radius of action, and such facilities for crossing gaps as will ensure its freedom of movement. The non-fighting vehicles must be kept to a mimimum of course, or the offensive power of the force will be reduced.

The next desideratum is that the organization should be a permanent one, as opposed to a temporary grouping of units when the need arrives. The speed at which the mechanicalized force has to move and fight is so great that its successful employment calls for an extremely high degree of tactical efficiency and, consequently, for much training in co-operation between its components. Therefore the force must be trained as a whole in peace, or it will fail to function efficiently in war.

Is the equivalent of a division to be taken as the permanent organization, or would a smaller force, say one corresponding to a brigade group, prove more suitable? In the writer's opiniom the latter is the one to choose. Though the role of the British Army is a varied one, the smaller force is, perhaps, more likely to be in demand than the larger one. Moreover the training of the brigade group column would be easier than that of the divisional formation, and in consequence, it would be possible to reach a higher standard of efficiency. Whichever force be adopted as the permanent one, it should, for the best results, be concentrated in one training area. There would be greater opportunities for a knowledge of the capabilities and methods of mechanicalized forces permeating the rest of the army, to the mutual advantage of all, if three mechanicalized brigade groups were stationed one each in, say, the Aldershot, Salisbury Plain and Catterick areas, than there would be if a mechanicalized division were located at one of these centres. For these reasons, therefore, the brigade group force will be adopted, and we will assume its organization to be as follows :—

Mechanicalized Brigade.

Brigade Headquarters.

Regt. Armoured Cars (3 coys. each of 16 armoured cars, semi-track).

Tankette Bde. (4 Bns. each of 48 two-men tankettes).

Tank Bn. (3 Coys, each of 48 Vickers tanks).

Field Bde. R.A. (mechanicalized, Dragons).

Field Coy. R.E. (mechanicalized).

The main characteristic of this force would be that every unit and every vehicle would move ready for instant action. The speed of the armoured cars would be 30 miles per hour along roads and 15 miles per hour across country, that of the rest of the force 20 miles per hour on roads and 10 miles per hour off them. The whole force would have a 300-mile radius of action and every unit would, for this distance, be self-contained as regards fuel, munitions, supplies and spares.

As regards ability to move across country, it may be taken that ordinary hedges, banks and ditches would present no difficulty to the force. The track vehicles could negotiate ditches up to 6 feet wide and banks up to 4 feet high with a slope of 1 in 2. The armoured cars with their greater speed would be able to make a detour round obstacles they could not cross. In addition, it is assumed that the tank battalion will include a number of bridge-laying tanks, say two per company, which can bridge gaps up to 15 feet without exposing their crews. These bridges could be used by all units of the force.

The capabilities of the field company with the mechanicalized brigade will be dealt with in the next section.

Partial Mechanicalization and the Engineers.

What is required of the Engineers.—Having discussed the effects of partial mechanicalization upon warfare, and evolved a possible composition for the mechanicalized force which is to be the feature of this stage, we are now in a position to examine the engineering needs of the army, and to see how they are to be met.

Mechanicalization being a process of evolution we may expect armies in this period to include formations in all degrees of formation. It is intended for the sake of clearness, however, to deal with them in only two categories:—(*a*) completely mechanicalized forces; (*b*) other forces. Engineers will be required with both and, though the principles of their employment will be the same in each case, their methods of performing their duties may differ considerably, just as the work of a field squadron varies from that of a field company. So we will take the two separately.

Let us begin with our permanent mechanicalized formation, the mechanicalized brigade. The fundamental principle governing the employment of this force is mobility. Freedom of movement will be the keynote of its success. This clearly indicates the primary

function of its engineers. They will have to assist the force to retain its mobility. In other words, their most important duty will be bridging. They must be able to get the mechanicalized force over any obstacles it may meet and which it cannot cross unaided.

The tactics of the mechanicalized force are essentially offensive. Its aims will be to deal the enemy a paralyzing blow, and to do this it may strike directly at the hostile forces or at some vital point in rear. In the former event it may be desired to cut the enemy's line of retreat and so prevent his escaping the blow, whilst in the latter the objective may well be the destruction either of some industrial plant or of an important bridge or railway crossing. Operations of this nature will demand an extensive use of what may be termed offensive demolitions. The latter may be wanted for purposes of defence as well. Should an attacking force wish to prevent the intervention of a hostile contingent before it had gained its objective, the destruction of crossings which the enemy had to use and the laying of minefields in areas he must pass, might delay the latter sufficiently, whilst avoiding the necessity of making a large and, perhaps, ill-spared detachment for the purpose. In the case of a withdrawal, obstacles of all forms, demolitions, mines, barricades, etc., will be needed to force the enemy off the roads and across country, thus slowing up the pace of the pursuit. On these occasions time will be of the utmost value, and it will rarely be possible to erect elaborate road blocks or barricades. The demolition of some crossing is usually the most rapid, and at the same time most effective, method of checking the enemy advance. Caution may be imposed on the pursuer, too, by the judicious laying of mines, and where it is possible to explode one under an armoured vehicle in a narrow defile, a serious block may be caused.

Not much is likely to be required in the way of field fortifications. The mechanicalized force's best defence is its mobility. It is unsuited to the occupation of positions and passive defence. As a rule it will only have to hold a locality until it can be relieved by the other forces in rear, and it will probably rely on rapid counter-attack as its most potent means of defence.

To sum up: bridging, demolitions, mines and obstacles will form the most important of the duties of engineers with the mechanicalized force. In the execution of these tasks the dominating factor, consistent with adequacy, will be speed.

What about the engineers with the rest of the army? The latter's role and consequent requirements will depend mainly upon the operations of the mechanicalized force. If these have been successful, and the rest of the army has merely to take over the ground gained, its chief need will be mobility, so that there may be no delay in freeing the mechanicalized force for a further advance. So far as the

engineers are concerned, this implies bridging and road communications generally.

There is always the possibility that the hostile mechanicalized forces may evade those of the attacker and strike at the other forces in rear. Consequently these must be prepared to resist a sudden mechanical attack. There will seldom be time for elaborate field works. As a rule the most that can be done will be to narrow down the possible avenues of approach so as to give the defending artillery more chance of coping with the attack. Demolitions, mines and obstacles are the best means of thus restricting movement.

Where an army is inferior as regards mechanicalized forces, its chief engineering need will be protection against mechanical attack. Though there can be no question of providing defences along an extended front, a great deal will be possible in the way of improving and strengthening natural obstacles.

Generally speaking, therefore, the engineering tasks will be much as they were for the mechanicalized forces. But there should be more time for their execution, and in consequence the work will be more elaborate and more extensive. Bridges will have to take heavier traffic and will be used more ; minefields will be wider, and obstacles will be more numerous and stronger.

Changes to meet the New Conditions.—We must now consider the organization of the engineers for these tasks. In the period of improvised mechanicalization the divisional and corps engineers were equipped with wheeled mechanical transport. No cross-country vehicles were provided for them, and their tools and organization remained essentially as they were at the close of the Great War. The mechanicalization of the engineers has now to be continued a step further.

We will take first the engineers with the mechanicalized brigade. This force, as we have seen, is to have a permanent organization. It will operate to a large extent apart from the remainder of the army and its tactics will to some extent be peculiar to it. If the engineers are to co-operate efficiently with the force, they must live with it and be trained with it. They must form a part of it in peace as well as in war. Temporary attachment would not meet the case. Hence the first essential of the new engineer organization is that it should be a permanent part of the mechanicalized brigade.

The next point is the strength and equipment of this engineer unit. It will be governed by the nature and extent of the tasks required from the unit by the mechanicalized brigade. The most important of these, as we have seen, are bridging, demolitions, mines and obstacles. There are many others, but these four may be looked upon as the chief tactical functions of the engineers, and their organization must be based upon them. We will deal with the four *seriatim* :—

(*a*) *Bridging.*—We have assumed that the mechanicalized brigade can negotiate gaps up to 15 feet unaided. For wider spans engineer assistance will be needed. To what extent should bridging material be provided ?

The mechanical brigade must effect its passage over obstacles by surprise. The crossing of any considerable gap with a determined enemy in occupation of the far bank would not be a feasible operation. It is essential that the bridge be launched where the enemy is not ready to resist it, or where he can only oppose it with machine gun and rifle fire. Surprise is obviously necessary, therefore. It can be achieved by speed, that is to say, by reaching the obstacle so far in advance of the enemy that there is time for the bridge to be launched and for sufficient of the force to have crossed over before the opposition is in strength. Air reconnaissance and wireless telegraphy have increased the rate at which information of such an attempt may reach the enemy, whilst mechanicalization has given him the means of rapid movement to forestall it. Under the most favourable circumstances it is doubtful if the bridging party could count on more than six hours in which to complete their task, and it will often be less.

If surprise cannot be obtained by speed, it may be gained by dispersion ; by attempting the crossing at more than one spot in the hope that the enemy will either have so distributed his forces as to leave them too weak everywhere or, that he will have concentrated at some spots and left others unguarded. Time will again be the deciding factor, and we cannot rely on a more generous allowance than we have made for the single crossing. Moreover, an attempt at several places simultaneously demands a corresponding number of bridges. For our mechanicalized brigade four bridges, at least, would have to be carried.

Finally, there is the chance of securing surprise by concealment. The crossing might be made under cover of darkness, fog, in a storm, or by moving to the site concealed by woods, buildings, etc. It is unlikely that there will be any increase in the time available, and the successful employment of this method requires a standardised equipment and a highly-trained bridging personnel.

The *desiderata* of the bridging equipment may, therefore, be summed up as follows :—

(*a*) Maximum span to be such that it can be erected and launched within six hours.

(*b*) Provision to be made for four separate bridges.

(*c*) Type to be simple, and suitable for erection in the dark.

(*d*) Equipment to be standardised, and to form a permanent part of the engineer unit, so that the requisite training of the personnel may be ensured.

(*e*) It must be possible to assemble the bridge under cover, and then to launch it in face of machine gun and rifle fire.

(*f*) The transport required must not be such as will render the mechanicalized brigade unwieldy or impair its fighting efficiency by necessitating strong detachments as a guard.

The longest single span erected during the Allies' advance in the autumn of 1918 was 180 feet. There would be no great technical difficulty in designing a bridge of this span capable of taking the loads with the mechanicalized brigade. But such a bridge would not satisfy the conditions above. It could not be launched in anything approaching six hours, nor is it adapted to erection under cover and launching by pushing out, so that it could not be thrown across in face of hostile machine gun and rifle fire. Further, the provision of four such bridges would entail a far too lengthy column of vehicles. We must rule out bridges of this length. The need for them will usually be foreseen and special provision made. Something smaller is required for the normal purposes of the mechanicalized brigade.

The Inglis bridge, rectangular type, Mark II, with 15-foot bays, will carry 35-ton tanks over 105 feet. It has been designed so that it can be made up complete under cover, and then pushed across country by a tank and over the gap without the use of special platforms or runways. It can be launched in this manner over a 70-foot gap or, in very good conditions of ground, over a 100-foot gap. With trained personnel the erection and launching of the steelwork can be done in 2½ hours. All the launching operations can be controlled from within the tank, and can, therefore, be done in face of machine gun and rifle fire. A party of some 50 sappers is suitable for the construction of the bridge. Its weight is 6 tons per 15-foot bay, and it can be carried in 28 three-ton lorries or an equivalent number of tracked vehicles.

This bridge satisfies the conditions we have laid down. It will not, however, be feasible to include four 105-foot spans with the mechanicalized brigade. If the bridging train is not to be unduly long a total length of 120 feet is about the maximum that can be taken. By providing 4 sets of launching frames, it would be possible to erect four 30-foot span bridges, or two 60-foot ones simultaneously. And a single bridge of 105 feet could be built if necessary.

The Inglis rectangular bridge, Mark II, will be adopted, therefore, as the standard type, and the engineer organization must be arranged for its erection, either in several small parts or as one 105-foot bridge.

(*b*) *Demolitions* :—These are primarily the task of small detachments of which several may be required at the same time. Work of this nature will not vary greatly from that for which the divisional engineers are trained at the present day. With the existing field company organization, however, there is no special demolition detachment. There are several reasons why provision should be made for this in the engineer unit of the mechanicalized brigade. In the first place, the bridging work is of such importance, and demands

for its efficient and rapid execution such a highly-trained personnel, that it is undesirable that duties other than bridging should be included in the latter's normal role. To do so would not only prevent their acquiring as high a standard in the work of bridge erection as they would be likely to do if that formed their sole duty, but it might lead to a weakening of the strengths of the bridging parties below the level at which they could function efficiently. Demolitions frequently involve dispersion of the parties engaged in the work over considerable areas. Apart altogether from the casualties likely to be incurred at the work, the question of concentrating these parties afterwards for a bridging operation would be a difficult and often an impossible task, in view of the speed at which the mechanicalized force moves. We may conclude, therefore, that demolition work should not normally be done by the bridging detachments. It must, then, either be the function of a separate unit or of a special detachment in the company that finds the bridging sections. The former method appears unnecessarily extravagant of engineer troops. It is likely, too, to introduce difficulties as regards command. If there are more than one engineer unit with the force there must be an officer superior to both commanders to co-ordinate their work. By including the demolition detachment under the same command as the bridging work the force commander will have only one engineer officer to deal with. Moreover, it will be quite feasible to give the demolition personnel sufficient training in bridging duties to enable them to replace casualties in the bridging sections. For these reasons the demolition detachment should form part of the same engineer unit as the bridging sections, though its personnel would normally move and work separately from the latter.

(*c*) *Mining*—As we have previously stated, the extent to which mines can be used will depend primarily upon the transport available to carry them. Suitably placed minefields impose caution upon the pursuit, and so delay the pursuer. In certain cases they may form a very efficient obstacle, as, if laid in a defile or on a causeway and exploded beneath an armoured vehicle, the route may be very effectively blocked. Only a small charge of high explosive is required to break the tracks of an armoured vehicle and so bring it to a halt. A mine weighing not much more than 10 lbs. should be all that is necessary. With these small mines a minefield could be laid very quickly, and would not be easily detected by an advancing enemy. Their real disadvantage lies in the question of supply, for a considerable number will always be necessary to ensure adequate results from their employment. A mechanicalized brigade group cannot carry a very great quantity, so their use is likely to be limited to situations of urgency (*e.g.* retreat), and to positions such as defiles, roads, etc., which it is reasonably probable the enemy will use, or which it is important he should not be allowed to cross unmolested. Mines,

therefore, will be primarily used as a means of defence, and hence, probably in conjunction with defensive demolitions. Their transport and laying will best be provided for by the demolition detachment.

(*d*) *Obstacles.*—These, like mines, are measures of defence. The two, in fact, really belong to the same category, mines being merely a special type of obstacle. Mines will usually form the quickest means of creating an obstacle, but their limited quantity may necessitate the employment of other methods to supplement them. These will take the form of blocks designed to make the enemy leave the roads and move across country. They will be of little value in open country, where a short detour will avoid them. But in wooded country, mountainous or marshy areas, and in large towns, their value may be considerable. Wooded country lends itself to the construction of barricades across roads by felled trees. In mountainous districts, demolitions at narrow and difficult places in the roads are probably most effective. Roads or tracks across marshes can only be blocked by the creation of gaps in them. As a rule, it will not usually be feasible to create gaps so large that they cannot be easily bridged. Mines are probably more efficient generally in such cases. Movement through town areas can be checked and delayed by barricades, the material for which will be obtained most quickly by demolishing buildings with explosives, and by placing vehicles which have been rendered immobile across the roads. Work of this nature can all be carried out by the demolition detachment. A liberal supply if explosives is essential, and vehicles capable of dragging heavy weights would be useful.

To sum up the requirements of the mechanicalized brigade group as regards its engineers :—There should be one unit capable of finding 4 bridging detachments, each of which will be able to erect a 30-foot bridge, and is self-contained as regards the material, transport and personnel required for this, and, in addition, a demolition detachment provided with personnel, explosives, tools, and transport for the demolition of at least 6 bridges simultaneously,for crater work in roadways, for the demolition of banks, cuttings, causeways, the destruction of buildings, the erection of road barricades, felling of trees and the laying of minefields.

We must now turn to the engineers employed with the rest of the force. It is not proposed to deal with these at great length. Their role will not be altered essentially from what it was in the first stage of mechanicalization. To a certain extent, however, it will be rendered more difficult, since the forces they are working with will be more liable to sudden attack from the enemy's mechanicalized forces. Apart from bridging, the importance of which remains unchanged, the provision of anti-tank obstacles will, therefore, become more urgent. The methods employed for these will be similar to those described for the engineers of the mechanicalized force. The

need for more elaborate and extensive work is evident, however, since the unmechanicalized force is not adapted to resist the mechanicalized one without suitable obstacles, natural or otherwise, and failing such, has not the same power of movement by which to avoid the encounter. Whilst, therefore, we may accept the organization adopted for the stage of improvised mechanicalization as being still generally applicable, provision will have to be made for a more extensive use of mines and obstacles. This implies movement across country, because in this case the mines and obstacles are wanted, not only on roads, but at weak or exposed points along the whole front. To fulfil their roles at adequate speed the engineers must consequently be provided with cross-country vehicles.

The further Mechanicalization of the Engineers.—It now remains to detail the organization of the engineers in accordance with the conclusions arrived at above. The following are the writer's proposals :—

(*a*) Engineers with the Mechanicalized Brigade—

1 FIELD COMPANY R.E. (Mechanicalized).

Composition—Coy. H.Q.. . . . . Major, Capt., C.S.M., C.Q.M.S., Clerk.

Headquarter Wing :—Wing H.Q., Capt., Clerk, Orderly.

No. 1 Group. (demolition section) 2 Subalterns and 54 O.Rs.
No. 2 Group. (administrative details, orderlies, etc.)
No. 3 Group. (technical stores and tools). (4).
No. 4 Group. (reserve bridging section). (5).

4 sections :— each 2 Subalterns and 54 O.Rs.

Transport— Coy. H.Q. . . . . 2 light track vehicles.

Headquarter Wing :—Wing H.Q. 1 do do vehicle.

No. 1 Group.	2 do do vehicles and 4 dragons.		(1).
No. 2 Group.	1	dragon	(2).
No. 3 Group.	2	dragons	(3).
No. 4 Group.	4	do	(3).

4 sections :— each 2 light track vehicles 4 dragons (3).

(1) Each 2 N.C.O.'s, 12 O.R.s, explosives and tools.
(2) Cooker trailed.
(3) Each dragon with a trailer.
(4) Reserves for No. 1 Group and the 4 sections; includes mines.
(5) Material only for one 30-foot bridge.

(*b*) Engineers with the rest of the army.

Per division. . . . . .H.Q. DIVISIONAL ENGINEERS.
FIELD PARK COMPANY.
3 FIELD COMPANIES.

No change has been made in the organization of the divisional engineers. Their transport, however, is now all track, and additional vehicles have been added to carry mines, the supply of which is replenished from the ammunition company, R.A.S.C.

Per Corps. . . . .Army Troops Companies, Bridging Parks and Pontoon Trains allotted as required. All equipped with wheeled mechanical transport.

III. THE THIRD STAGE—FULL MECHANICALIZATION.

Mechanicalization as it is likely to concern the present generation is comprised within our two first stages. But there is small chance that the transformation will stop there. So far as can be foreseen, the replacement of man-power by machine-power will continue much further. It may even reach the ideal army consisting of one man who, by pressing a button, puts into operation war machines evolved by the best brains of the nation during peace time (1). However, such a distant view hardly comes within the scope of this article, and the writer does not propose more than a glimpse into the immediate future.

The facts that formed the foundations for our conclusions concerning the first and second stages of mechanicalization are no longer available. We shall have to quit the sure paths of knowledge and attempt the quicksands of conjecture. Yet it may be that there will be some gain from this, nevertheless. Dreams of the future ought not to be allowed to obscure the actualities of the present. But this does not imply that advanced thought should be ignored. Far from it. Those who keep in close touch with scientific progress will be able to take prompt advantage of what science offers. They will have the opportunity of adapting a new discovery, or process, to the military needs of their country and in advance of her rivals. By such means surprise in material, one of the most potent and lasting forms which this most powerful of weapons may take, can be achieved. This is ample reason for looking ahead, and it applies to the science of mechanicalization as to others.

What, then, can we see of the war of the future? Every indication points to the eventual disappearance of man as a self-propelled agent of war. Whole armies will be carried to the battlefield and through the fight. Full mechanicalization will provide the soldier with the means of movement, equip him with the powers of destruction, and armour him against the enemy's weapons. Man's functions will be to guide and control the machine.

(1). "Tanks in the Great War" (Fuller), p. 310.

Battles may well assume some of the aspects of a naval action. As the evolution of the mechanical vehicle progresses so will its ability to traverse all natures of surface improve, until difficult country offers no greater obstacle to its advance than a rough sea does to the manœuvres of a man of war.

Consequently, trenches as we now know them, and all the ordinary types of obstacle, will become useless. In fact, field defences of all sorts will be obsolete. Nothing but permanent works on a scale far greater than anything now contemplated will afford protection from the mechanical attacks of the future. We may picture the defences of this era as consisting of enormous moats and vast minefields. Their construction in time of war would be impossible. Fortification therefore, will be done in peace time. It will be necessary, in order to secure our great strategic and industrial centres, our land and air ports, power stations, fuel depots and the like. The development of the air arm, a phase of mechanicalization, but one which has not been dealt with in this paper, will probably by this time have driven all important centres, depots and quarters underground, whilst progress in chemical warfare will have rendered futile any defences which are not gastight and supplied with " tinned " air.

Truly the future of warfare provides ample food for speculation. But sufficient rein has been given to the imagination. There will be little benefit in proceeding further. We will content ourselves with noting that, no matter how far ahead we look, and no matter what changes in war and its conduct take place, the need for the engineer remains. The effect of mechanicalization in no way tends to diminish his value as an auxiliary to the fighting arms, whether the latter be represented by men or by machines. It will, however, make the execution of his task more difficult unless mechanicalization be called in to aid him. The tank is the answer to the tank. In the same way " mechanical " engineering must be used to counter the effect of mechanical warfare.

THE INFLUENCE OF INTELLIGENCE UPON THE TANNENBERG CAMPAIGN.

By BREV.-MAJOR B. C. DENING, M.C., *p.s.c.*, R.E.

FOR reasons which at first sight are not very apparent, the influence of Intelligence upon the conduct of war has not that prominence in the writings and teachings of the leaders of modern military thought that might be expected in view of theimportant part Intelligence has played in the wars of the past. Any soldier to-day, if asked, did he consider Intelligence a matter of paramount importance in war, would unhesitatingly reply in the affirmative. Yet rarely in the many studies which have been made of the events of the late war is full credit given to the effect Intelligence has had upon Operations. Possibly this is due to the fact that few of the military battles of the last war were in themselves decisive, and in consequence the direct connection between good information obtained and results achieved is not easy to trace. Whatever the cause, unless the value of Intelligence in any form of war, past or future, is ever before us, its study in peace is likely to be neglected, and its absence in war is certain to be accompanied by the failure of operations.

Of all the battles of the last war, the most spectacular, if not the most far-reaching in effect, was that in which the Germans obtained a decisive victory over the Russians in East Prussia, in the vicinity of the village of Tannenberg. For many reasons the Tannenberg campaign is worthy of study. The conditions of the campaign were those of the type of warfare known to-day as open warfare, *i.e.*, those which all soldiers hope are likely to prevail in future. The opponents, upon paper at least, were evenly matched, the superior numbers of the Russians being balanced by the greater mobility, the better equipment and higher staff work of the Germans. Finally, the results of the main battle, where the completion of the manœuvre of double envelopment ended in the encirclement and destruction of the greater portion of the Russian Second Army, were not equalled in any other of the successful battles of the war, and resembled more the era of Sedan than that of the Somme and Verdun. This battle is a suitable one for the investigation of the influence of Intelligence upon Operations.

The Battle of Tannenberg is fully described in General Sir Edmund Ironside's book, "Tannenberg," which itself is based upon three English, seventeen German, and six Russian books of reference. It is not proposed to touch in detail upon the various actions which led up to, and followed the disaster of Tannenberg, but merely to point out the stages at which the possession or the lack of information had a vital effect upon events.

To begin with, the equipment of the two sides for obtaining Intelligence is interesting. The Germans used a certain number of reconnaisance aircraft, the Russians did not. Both armies possessed wireless, but, whereas the Germans realized the danger of indiscriminately using this method of communication, the Russians failed to do so, and either broadcasted their orders in clear, or used such simple cypher, that the enemy successfully intercepted the messages sent. The Russians possessed a considerable superiority in cavalry, but had no conception of the use of the mounted arm for the purpose of obtaining information, whereas the Germans were well served with reports by advanced detachments. The Russian signal communications were so deficient that the superior Commanders had sometimes little knowledge of the whereabouts even of their own troops. The German communications were excellent. Such were the conditions under which the fighting started.

The campaign of Tannenberg may be briefly summarised under the headings of :—

The Battle of Gumbinnen (Aug. 20th, 1914).
The Battle of Tannenberg (Aug. 26th to Aug. 30th, 1914).
The Battle of the Masurian Lakes (Sept. 9th to Sept. 14th, 1914).

The Russians advanced with their First and Second Armies (see Sketch "A" attached), the former of approximately three Corps and five Cavalry Divisions, the latter of about six Corps and three Cavalry Divisions. The Germans had in East Prussia to oppose them, the Eighth German Army the equivalent of five-and-a-half Corps and one Cavalry Division, though one additional division arrived from Germany for the Battle of Tannenberg and two corps from France for the Battle of the Masurian Lakes. The essence of the Russian plan was to unite their two armies on the battlefield in East Prussia, where they would be in a superiority of nearly two to one.

The German plan was based upon their ability to meet the Russian armies singly, and to defeat them in turn. The dependence of both plans upon good information, both with reference to enemy movements and the progress of the troops of their own side, is too obvious to require further emphasis.

THE BATTLE OF GUMBINNEN.

By 14th August, Eighth German Army Headquarters in East Prussia had information, from sources not stated, of the approach of the Russian First Army in the North, but none of the advance of the Russian Second Army from the R. Narew, as the following extracts from a German Army Order (1) show :—

> "It appears not unlikely that the enemy may advance South of the Forest of R. . . . . His advanced troops—Infantry and Artillery—are advancing from the line Gr. C.—M." (both on the frontier, about 35 miles South of Gumbinnen).

(1) General Ironside's "Tannenberg."

"The army will concentrate on its left flank to take the offensive against the enemy's advance, etc., etc. The covering of the right flank of the Army against the, in any case, *very unlikely event of a Russian advance from the Narew*, (2) is placed in the hands, etc., etc."

The German information was as accurate as could be expected. The First Russian Army extended in fact further north than reported, while the Second Russian Army did not commence to arrive at the frontier until 20th and 21st August.

On the Russian side, early in August, raids to a considerable depth by cavalry of the First Army identified the 1st German Corps and 1st Cav. Div. Continuous touch was not maintained, however, nor was the German protective screen penetrated, as it might have been with the superiority in cavalry possessed by the Russians. The Russians had thus no news of the concentration of the Eighth German Army, which took place between 15th and 20th August, for the fight at Gumbinnen.

On the 19th August, at a most critical point, the Russian Order giving the dispositions and plans of the First Army for 19th and 20th August were issued by wireless. These were picked up *in toto* by the Germans. Rarely in the history of war can a commander have received such intelligence as fell to the German leader of the Eighth Army on that day. He was made aware of the plan of the First Army to halt on 20th August. The Germans did not, or were not, able to make full use of the information they possessed at Gumbinnen. It is true that they attacked the Russian Army, but with only a limited measure of success, the attack being too hurriedly mounted and being delivered piecemeal. Had they been able to wait one day longer, and had the German corps attacked on the 21st in line, the story of Gumbinnen would have been a very different one. As it was, Intelligence was again affecting the operations, this time adversely. The information which reached the German Army Commander by 20th August is well summarised in a telephone conversation between him and a Corps Commander :—(3)

"The situation has completely altered. New forces have appeared in the North. . . . . Fresh forces of about an Army Corps have appeared about Lyck. The Narew Army is advancing in strength. . . The Eighth Army is, therefore, going behind the Vistula."

The effect of this intelligence, particularly that relating to the Russian Second Army moving from the Narew, was to take the whole sting out of the German offensive. The Russian First Army, quite by accident, for it had no information and had halted on 20th August, had almost succeeded in retaining the greater portion of the German forces opposite it until it was too late for them to move back to meet the new danger in the South.

(2) Writer's italics.
(3) General Ironside's "Tannenberg," p.101-102.

THE BATTLE OF TANNENBERG.

After the fight at Gumbinnen, the Germans did not, in actual fact, "go behind the Vistula," but left one Cavalry Division in observation along the whole front of the Russian First Army, and moved three-and-a-half Corps, two by road and the remainder by rail, to the Tannenberg area. Thus a few German Cavalry fixed the Russian First Army, while the Russians had little conception of the location of the German forces. The German Eighth Army, placed at this point under Hindenburg and Ludendorff, gambled on the slowness of the advance of the Russian First Army to give them time to meet the Second Army. Had the Russians but known, the First Army had only to move forward to render the position of the Germans in East Prussia quite untenable. Ludendorff, referring to the First Army Commander, says :—(4) "He need only have closed with us and we should have been beaten." To lack of Intelligence as to the true state of affairs, even allowing for all other reasons, must be attributed this criminal inactivity on the part of the Russians in the North.

As regards the information possessed by the Second Russian Army prior to Tannenberg, General Ironside shows this to have been scant. The Army Commander reported on 20th August to higher authority :— (5)

> "The frontier roads are very heavy. Reconnaisances, therefore, were only short. *Enemy aeroplanes followed the movements of the Army all the time.*" (Writer's italics).

The Second Russian Army blundered on, only vaguely aware of the presence of some enemy in front of them.

As regards the information which the Germans obtained, in addition to their air reports, General Ironside tells us :— (6)

> "The order giving the dispositions of the Second Army for the 24th was sent (by wireless) *in clear*!"

It is hardly to be wondered at, therefore, that between the 26th and 30th August a practically blindfolded Russian Army was surrounded and cut up by a German Army roughly equal in numbers, but possessed of knowledge which made the situation to them as clear as day. There can be little excuse for the Russians, who might have neutralised the fatal use of wireless by the active employment of their 50 squadrons of Cavalry available here against some 9 German Squadrons.

Even during the battle the Germans received valuable Intelligence. Towards the end of the battle (7), the Russians collected the equivalent of a fresh division and launched an attack intended to break the southern enveloping wing of the Germans. Ludendorff says :—

(4) "My War Memories, 1914-1918," by General Ludendorff, p.49.
(5) General Ironside's "Tannenberg," p. 127.
(6) General Ironside's "Tannenberg," p.146.
(7) General Ironside says on 30th (p. 190); Ludendorff says on 29th. ("My War Memories," p. 56).

"Early on 29th we received a message by aeroplane that a hostile Army Corps was marching on Neidenberg from the south. . . . . It was, therefore, threatening the rear of the 1st Army Corps, which, with its front facing north, was engaging Russian troops in retreat."

The aeroplane in question warned both the 1st Army Corps and Ludendorff. General Ironside states that five divisions were diverted to meet the new danger.

As a result of this battle five Corps of the Second Russian Army were annihilated.

The Battle of the Masurian Lakes.

Immediately after the battle of Tannenberg, the German forces, reinforced by two Corps from France, were turned again against the Russian First Army which had slowly advanced. This advance ceased as the news of the disaster in the south became known, and the Russians withdrew somewhat and took up a defensive position. Again the Germans had complete knowledge of the Russian dispositions, owing to the irresponsible use of wireless by the latter. This time, however, the tactical situation did not permit of the complete envelopment. Though the German right flank fought several successful actions east of the Masurian Lakes, and effected a wide turning movement, it was not able to cut off the retreat of the Russian Army. An opportune counter-attack by the Russian centre gained valuable time, and the German victory became indecisive. The Russian Corps were extricated without disintegration, and retired once more over the frontier.

Conclusions.

It were unwise not to take into account various other factors in assessing the influence of Intelligence upon the campaign of Tannenberg. General Knox has given an excellent picture of certain of the scenes behind the Russian lines, notably in the Second Army area:—(8). It is clear that the Russians suffered from lack of commanders of any ability, and lack of good staff work. They were hurried forward so fast that supplies ran short almost at once, and so that by the end of the Battle of Tannenberg men and horses were literally starving. The armies were so ill deployed that Corps were not within supporting distance of one another, and were defeated in detail. On the German side, Ludendorff claims that :— (9)

"To the training of our army in peace time, alone did we owe this feat."

Certainly the Germans had roads, railways, motor transport, signals, everything that the Russians lacked. Yet is it too much to maintain that, in spite of all these contributing factors, no decisive battle would have been won had Intelligence reached both sides in equal quantities ?

(8) "With the Russian Army, 1914-1917," by Maj.-Gen. Sir A. Knox, K.C.B., C.M.G.
(9) "My War Memories," p. 57.

Let us suppose that Russia throughout had used her cavalry in a reasonable manner. Must they not, before each of the battles, have gained some knowledge of the extent of the German forces and given the Russian leaders something upon which to base their attacks and their assumptions? Had the Russian cavalry followed up the German retreat after Gumbinnen, surely no Battle of Tannenberg could ever have developed as it did, whatever the chaotic condition behind the Second Russian Army. And had the latter army used its cavalry in the most elementary manner could it possibly have fallen into the trap prepared for it?

And, conversely, though the reports from the air were invaluable, could the German plans at all three of the main battles have matured so quickly had the wireless not located every hostile formation on the front. And without the speed in them, the Germans plans could not have brought decisive results.

The writer is of the opinion that had Intelligence on both sides been obtained as it should have been, in spite of all their other disabilities, *the Russians* would have won the campaign of Tannenberg, by forcing, if only gradually, the retreat of the German Army by the converging pressure from north and south.

THE LESSONS FOR THE FUTURE.

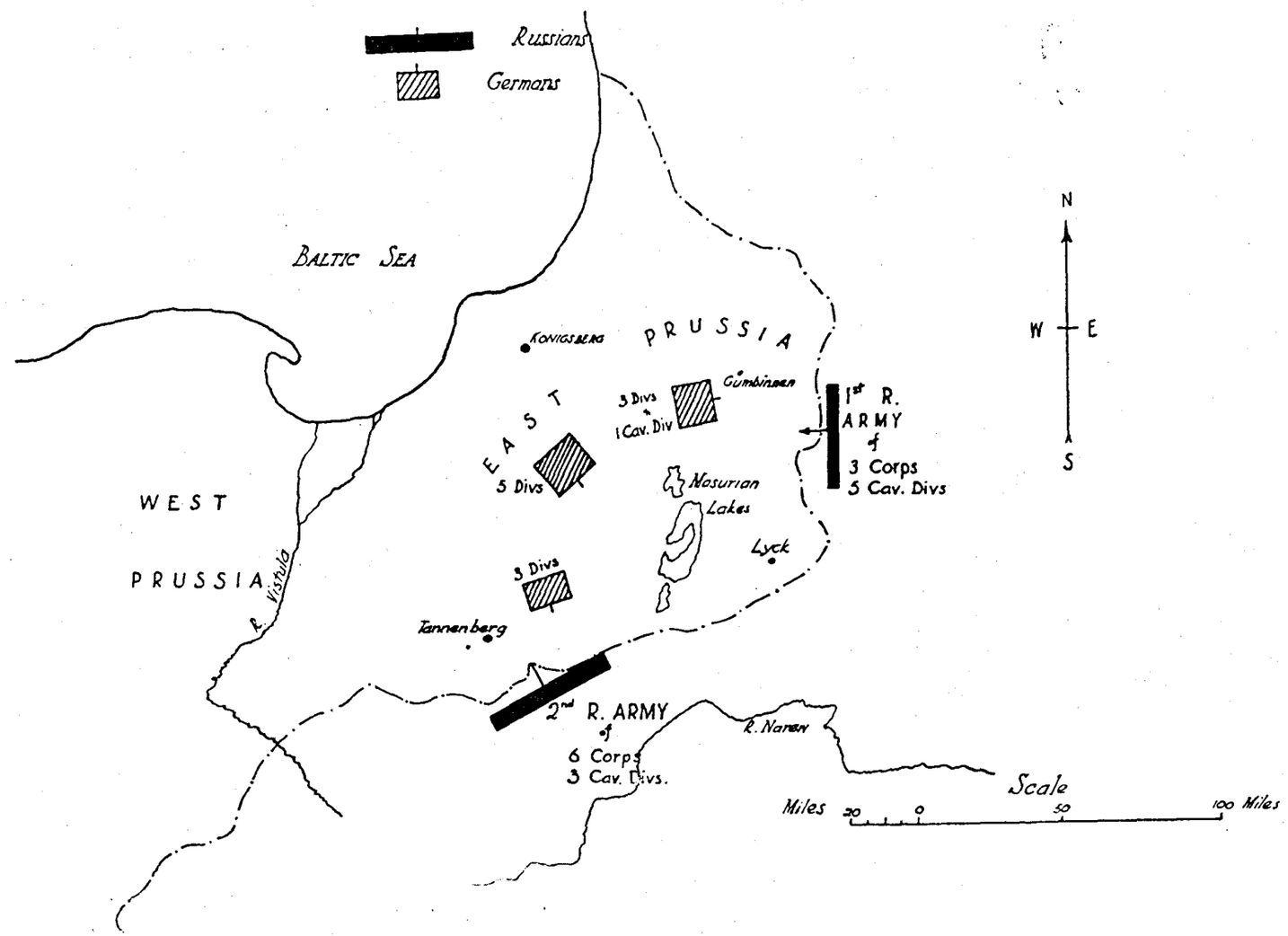
The lessons for the future are clear. No military power must ever again allow Intelligence work, both preventive and productive, to be so neglected as to bring troops to such a pass as that of the unfortunate Russians at Tannenberg.

It is pretty generally realised to-day how carefully the use of the wireless in the field must be handled if vital information is not to be divulged. It is doubtful whether other means of preventing information reaching the enemy are as well appreciated. We should press on with the study of this side of the question, in order to force our enemies to fight in darkness as the Russians did in the campaign just discussed.

Conversely, we must in peace think out and organise all possible means of obtaining Intelligence. The German handling of their cavalry and advanced detachments before and after Gumbinnen show well what can be done by trained troops. It requires to become second nature to our forces, whenever contact has been obtained with an enemy, never to lose that contact, to find out every possible thing about that enemy, and to transmit the knowledge gained to higher authority.

INITIAL DISPOSITIONS IN THE TANNENBERG CAMPAIGN.

Sketch "A"



HISTORY OF THE 20th (FIELD) COMPANY; ROYAL BOMBAY SAPPERS AND MINERS.

GREAT WAR: 1914—1918.
(*Concluded*).

By MAJOR H. W. R. HAMILTON, D.S.O., M.C., R.E.,

"Acti labores sunt jucundi"

PART II.—MESOPOTAMIA.

JANUARY, 1916.

Basrah.—On the 7th January, 1916, the Company disembarked at Basrah, and moved on the 8th to Marghil. That night the camp was flooded by the overflowing waters of the Shatt El Arab—a foretaste of the future.

The next few days were spent in making arrangements for the march up-country. Rations were drawn, and kit and equipment renewed.

Arrangements were also made to leave behind the Maler Kotla Sappers, who henceforward formed a separate Imperial Service Company under their own officers.

The March Up-country. Map 6. On the 13th, the Company, leaving behind the Maler Kotla Sappers, started the march up-river, towing its equipment and thirty days' rations in "mahelas," as the native boats were called. Heavy rains fell; roads became impassable with mud; unbridged irrigation cuts had to be crossed; and more than once halts were necessary. Hence it was not until the 7th February that the unit rejoined the 3rd (Lahore) Division at El Orah on the right bank of the Tigris.

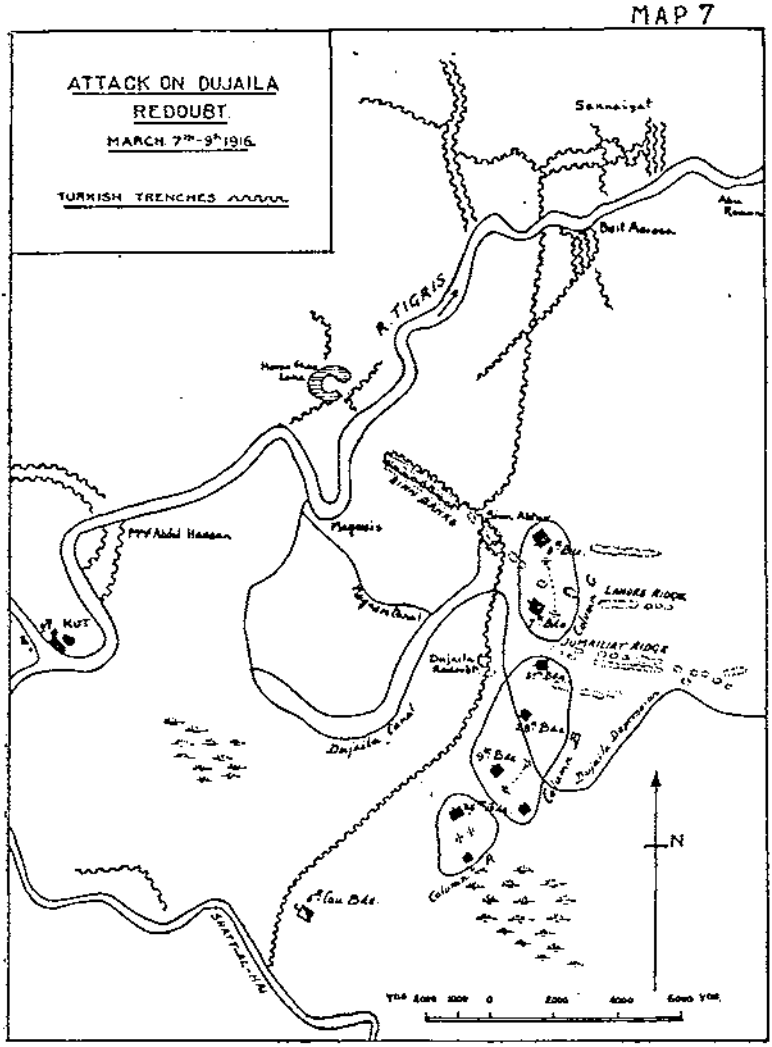
FEBRUARY, 1916.

General Situation. Map 9. Meanwhile the force, which was endeavouring to relieve Kut Al Amarah, had fought costly and indecisive actions at Sheikh Saad on the 6th and 7th, and at Orah on the 13th and 14th January, and had found further advance impossible after the unsuccessful attack on the Turks at Umm Al Hannah on the 21st of January. When the Company arrived,

therefore, the Turks were still holding the strong position of Hannah, on the left bank, with the even stronger position of Sunnaiyat behind them. On the right bank they had weak forces holding the Sinn position, which was continued on the left bank astride the Suwada Marsh.

The right flank of the Turkish Sinn position rested on the Dujailah redoubt. This was a large mound some 200 yards in length, rising about 50 feet above the plain, and overlooking the country as far as Magasis, the site of the Turkish ferry. It was strongly fortified, but weakly held.

MAP 7



It was now decided to make a night march up the right bank and capture the Dujailah redoubt by a surprise attack. It was confidently expected that with this strong point in our possession it

would be possible to join hands with the garrison of Kut, which still held a position on the right bank, up-stream of the Hai, at the Liquorice Factory (or Woolpress Village, as it was alternatively named).

The Company was now engaged in making up portable rafts and bridges, by which it was intended to cross the Hai. In addition, some dummy pontoons were constructed, and paraded ostentatiously on the river bank at Mason's Mounds opposite the enemy's line, in the hope of withdrawing his attention from the real point of attack,

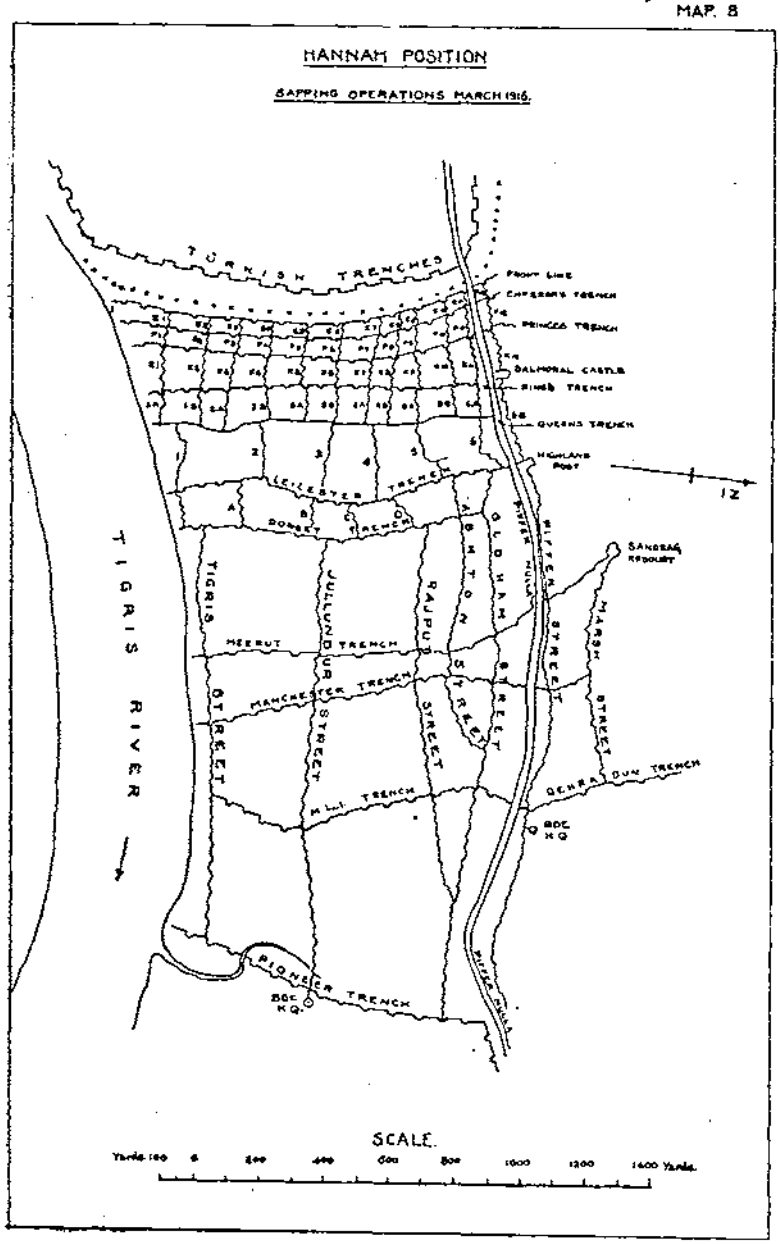
Battle of Dujailah. Map 7. On the evening of the 7th March, the attacking columns moved out of camp. Captain Arbuthnot and 14 other ranks of the Company, all picked men, marched with "C" Column. The role of this party was to assist in the consolidation of the Dujailah redoubt, as soon as it fell into our hands. The remainder of the Company marched at dawn on the 8th, as escort to the transport. Immediately on arrival opposite the Sinn position at 11.0 a.m., the work of sinking wells in the Dujailah depression, an old bed of the Tigris, was put in hand. Meanwhile Captain Arbuthn ot and his 14 men, having made dug-outs for the Headquarters of the 3rd Division, joined the attack of the 8th Infantry Brigade on the Dujailah redoubt. The exact course of subsequent events was difficult at the time, and is more difficult now, to discover. It was understood that Captain Arbuthnot entered the redoubt, and was finally the only officer left, with details of the Manchesters and other units, to hold it against counter-attacks. It is certain, however, that he and his orderly, Sapper Hira Singh, were killed here, and eight others of the party wounded. So fell two brave men.

All attacks on the Dujailah redoubt having failed, it was decided to withdraw the force. Accordingly, on the 9th, the Company returned to Orah with the remainder of the attacking columns.

Major S. Boyd, R.E., now assumed command.

Sapping at Hannah. Map 8. It was now decided to take the Hannah position on the right by means of the deliberate methods of siege warfare. Accordingly, sapping was started on the 15th March. The 20th Company crossed to the left bank to assist, and took over two saps on the extreme right of the position. Work on these saps and their connecting parallels was pushed forward with the utmost haste. Whenever possible, men worked above ground. and sapper units vied with each other in their efforts to make progress. Though the Turks endeavoured to hinder the work by fire, by the action of patrols, and by putting out bomb-traps, by the 2nd April the line had been taken some 400 yards forward, and the advanced parallel lay about 100 yards from the Turkish lines During this period one Sapper of the Company was killed and two slightly wounded. The Company was congratulated by the G.O.C. 3rd Division on its work here.

MAP. 8



APRIL, 1916.

Bunding." *Map* 9. On the 3rd April, the Company returned to the right bank, where until the 16th April, it struggled to make and maintain the river " bunds " at Baddhu Bend, Mason's Mounds, and Abu Roman. This was a period of great strain. The river was running in flood; there were torrential rains; and, if the

"bunds" had burst, the troops on the right bank would have been in a difficult situation.

Hannah position taken. Meanwhile the Hannah position, which the Turks had partially evacuated, was stormed on the 8th, but the Sunnaiyat position held out against attack on the 9th, and further progress on the left bank was impossible.

Battle of Beit Aiessa. Map 9. On the 17th, the 3rd Division attacked and captured the Turkish position at Beit Aiessa on the right bank. Fierce Turkish counter-attacks developed that night, but were repulsed with heavy loss. Even Turkish camp followers had been pressed into this effort, and many of those who took part in the action were of opinion that, if we had counter-attacked in turn, the remnants of the Turkish force could have been pressed across the Sinn position without difficulty.

"*Bunding.*" The Turks now cut the "bunds" up-stream of our lines, and placed our troops in a difficult position, with water pouring in on their flank, and a rapidly forming marsh in their rear. The Company first mended the river "bunds" under fire, with the loss of two men wounded, and then constructed communications across the marsh in rear of the front-line troops. It is not easy for anyone, who has not struggled with refractory water, to realize the difficulty of the task.

This important work having been completed, the ordinary work of consolidation and strengthening of the line proceeded, and at the same time water channels were opened from the river leading towards our left flank, which was now a considerable distance from the river.

Lieutenant Hamilton rejoined on the 28th April.

Fall of Kut-Al-Amarah. On the 29th April Kut-Al-Amarah fell. There was now no further use in pushing on, and work on improving our position therefore continued.

On the night of the 19th-20th May, the Turks, wishing to economise troops, withdrew on the right bank to the vicinity of the Hai. On the 20th, the 3rd Division followed them up; and the 20th Company, having moved with the leading troops, went into camp at the Dujailah redoubt, where it was employed in digging wells. Water was urgently required, as the Turks still held the left bank of the river, and might at any moment prevent the Division watering at Magasis.

Water Supply at Magasis. Map 9. On the 21st, the Company, having moved camp to a point nearer Magasis, started to deepen the Magasis Canal, so as to lead water to a point where it would be safe to water men and animals. Meanwhile the transport of the Division continued to water at Magasis, and, on the 22nd, the Company bathed in the river. The Turks remained singularly inactive and

did not attempt to molest the water-parties. The "water-truce" was first broken by our snipers, who inflicted a few casualties on the enemy, and thereafter the river bank became unhealthy.

As the river fell, it became impossible to fill the Magasis Canal by natural means, and an oil-engine and pump were erected in an excavation in the river bank. This work continued until well into June.

Meanwhile Corporal Clark and the Company's first-line transport rejoined after nearly 6 months' absence, and the unit again became completely mobile. Captain A. Mason, M.C., R.E., and Subadar Ganpat Mahadeo, I.O.M., were invalided about this time, the former suffering from the effects of the heat, and the latter from cholera, which had been fairly prevalent in the force.

JUNE, 1916.

Water Supply at Abu Roman. Map 9. In June, the 14th Division relieved the 3rd Division, and the Company returned to the vicinity of Abu Roman, where it was employed until the 3rd August almost entirely on water-supply. This comprised the erection of pumps and engines, the construction of tanks, and the cutting of canals to take water to camps distant from the river.

JULY, 1916.

Leave was opened in July, and a proportion of men and officers proceeded on leave to India. 2nd Lieutenant Stables, I.A.R.O., joined during that month.

For a long time the men had been receiving rations deficient in fresh meat and vegetables, and the troops were now attacked by scurvy. In two months the Company lost 60 men suffering from that disease. Many of the best N.C.O's. and men were thus lost; and this sickness proved as hard a blow as many battles.

AUGUST, 1916.

Work at Twin Canals. Map 9. On the 3rd August, the Company marched to Twin Canals, and started the construction of redoubts, or block houses as they were called, to protect the new light railway-line from Sheikh Saad to Sinn Abtar. These posts provided cover for a small garrison; they were sited about 300 yards apart, and had an all-round field of fire, and the intervals between them were closed by an apron barbed wire fence. Alarms and flares were constructed in order to increase the difficulties of Arabs passing the blockhouse line at night.

In addition, much work was carried out at Twin Canals on water-supply, local protection of the camp, and communications. Moreover the fact that active operations would recommence in the autumn

was not overlooked; Sappers, Pioneers and Infantry were practised in rapid wiring and trench-work.

Lieutenant Venables, I.A.R.O., left the Company about this time on being appointed Adjutant to the C.R.E., and Lieutenant Bowers joined.

As the season advanced the Arabs grew ever more and more bold, finding, it appeared, no difficulty in getting through the wire between block-houses, and carrying their depredations even as far as Divisional Headquarters on the river-bank. The Company, therefore, invented a bomb-trap, which held a Mills grenade. The latter was designed to explode when the wires of the fence were either raised or lowered. The work of fixing these began on the 1st November, and their presence undoubtedly deterred the Arabs from passing the block-house line nightly, as had been their custom. Lieutenant Hamilton was the first casualty, and had to go into hospital for a month; but an Arab was badly wounded a few nights later, though he escaped to warn his friends.

December, 1916.

Active Operations Commence. Map 9. On December 18th, the Company moved forward to Magasis, where it was attached to the 8th Infantry Brigade.

Meanwhile the operations, which were to lead up to the re-occupation of Kut and to the capture of Baghdad, had been started by the 3rd Corps (13th and 14th Divisions), which had moved forward on the 12th December to a position astride the Hai. The 3rd Division had at the same time advanced, and masked the Turkish position in the Muhammad Abdul Hassan bend.

Operations in which the 20th Company took part were now set on foot, with the object of squeezing the Turks out of the latter position.

The advance was deliberate, and carried out in methodical stages. Series of posts were pushed forward by night and wired, and connected together and to our old line, on succeeding nights. This continued until the advanced parallels were within assaulting distance of the enemy trenches. The work was hard, and sometimes hindered by enfilade machine gun fire from the left bank, but the Turks were less active than might have been the case. Night work in Mesopotamia was more trying than in France, as, owing to the clearness of the atmosphere, bodies of men could be distinguished easily on a moonlight night at 400 yards range.

January 9th, 1917.

The Attack. On the 9th January, 1917, the final assault position having been reached, two Infantry Brigades of the 3rd Division

attacked the Turkish lines at dawn. Major Boyd, Lieutenant Bowers and 2nd Lieutenant Wardle, I.A.R.O. (who had joined on the 8th), with the left half-company, accompanied the attack of the right brigade, the 8th, with orders to consolidate the captured trenches.

There was a thick mist, and at 10.0 a.m., a Turkish counter-attack drove troops on the right from the captured trenches, and uncovered the flank of the Sapper working party. Parties of Turks started working down the trenches on the right; and as he had no bombs, Major Boyd decided that it was impossible to continue the work and retreated to our original position. By the time this had been accomplished, two men had been killed, and Lieutenants Bowers and Wardle, and fifteen others, wounded.

During the course of the day the Manchesters recaptured part of the lost line, and in the evening the whole Company was used to consolidate the position.

The Turks pressed out of the Bend. Thereafter the work of pressing the Turks out of the bend continued; and the work of the Sappers was hard and continuous. On the 19th it was intended to make a final attack on the enemy and round-up his remaining troops, who had only a ferry behind them, but they retired across the Tigris on the night of the 18th-19th. Patrols soon reported that the bend was clear, and the final attack did not take place.

The following were the casualties during these operations:—

Killed	4 Indian other ranks.
Wounded	2 British Officers and
	1 Indian Officer (Jemadar Uttam Singh).
	28 Indian other ranks.

FEBRUARY, 1917.

General Narrative. Map 9. Henceforward the Company was employed on almost continuous night work, building up the "bunds" on the river bank from the Muhammad Abdul Hassan bend to Magasis, and in strengthening the piquets which guarded this long line of river bank. Lieutenant C. R Otto, R.E., joined the Company during this period.

Meanwhile the 3rd Corps had taken up the task of expelling the Turks from the right bank, and had captured Kala Haji Fahan and the Dahra bend by the 15th February.

On the 12th February, the Company moved to the left bank of the Hai, opposite the ruins of Kala Haji Fahan, and started work on the river "bunds" immediately opposite Kut. Here Lieutenant Bowers rejoined from hospital.

Having completed the work in this neighbourhood, the Company moved to near Divisional Headquarters at Es Sinn on the 22nd, and the next day shifted camp a mile or two further to the rear.

The Shumran Crossing. Map 9. The 7th Division, after an unsuccessful attack on the 17th, captured the Sunnaiyat position on the 22nd, and, on the 23rd, the Tigris was crossed at the Shumran bend, and a pontoon bridge thrown across the river there, enabling the 3rd Corps and the Cavalry to cross to the left bank.

The Turks had now to march hard to escape complete envelopment

The Company Marches to Dahra. At about noon on the 24th February, the Company received orders to join the 8th Infantry. Brigade on the left bank of the Tigris above Kut, leaving behind 2nd Lieutenant Stables and No. 4 Section as a dump guard. Marching at 2.30 p.m., it crossed the river by the Sandy Ridge pontoon bridge, and camped near the 5th line of the Turkish Sunnaiyat position at 7.30 p.m. The march was continued at 6.30 a.m. on the 25th, and the 8th Infantry Brigade Camp at Dahra was reached at 1.15 p.m. the same day. A total distance of 35 miles had thus been covered in 23 hours. Not a man fell out, nor indeed did a single man fall out all the way to Baghdad, though many men, having only the bare vestiges of socks, marched practically the whole way barefoot.

This was the first time during the war that the men had felt the exhilaration of following up a beaten enemy.

March, 1917.

The March to Baghdad. Map 6. On the 26th February, the Company marched with the 8th Infantry Brigade, and reached Sheikh Jaad on the 28th, where it remained until the 4th March, improving roads and destroying Turkish ammunition. It then marched a few miles up-river to Baghailah, the former site of a Turkish bridge of boats, which the enemy had jettisoned. The material of the bridge was salved as far as was possible, and some Turkish guns, thrown into the river further up-stream, were hauled, not without difficulty, on to dry land.

Marching again on the 7th, the Company reached Bawi on the 10th, halting at Shidaif Ash Sharqi, Aziziyeh, and Zeur en route.

Between the 7th and 10th March, the Diyalah had been crossed by the 3rd Corps after heavy fighting. Baghdad railway station was occupied by the 7th Division on the 10th, and Baghdad itself entered on the 11th.

On the 13th, the Company marched to Hinaidi with the 8th Infantry Brigade, and next day, passing round to the east of Baghdad outside the city walls, went into camp at Muazzam.

Operations on the Diyalah. The 15th March was spent in improvements to roads and water-supply; and on the 16th, the Company marched again with the 8th Infantry Brigade to Khan Bani Saad.

The column, to which the Company was attached, was intended to bar the retreat of the Turkish forces in Persia, via Khanikin and Qizil Robat; but its first objective was Baqubah, the site of a boat-bridge, where the Turks still held the left bank of the Diyalah.

On the 17th, the column marched to within a few miles of that town, which was situated almost entirely on the left bank of the Diyalah, and Sapper officers reconnoitred the river crossings below Buhriz, a village some three or four miles downstream of Baqubah.

That night the Manchesters and 59th Rifles were ferried across the river below Buhriz in pontoons. As there were very few of these the work was somewhat laborious. These two battalions then advanced up the left bank, and entered Baqubah, which the Turks had evacuated, while the remainder of the column marched to the site of the bridge at Baqubah. This had been broken, but a pontoon bridge was thrown across, supplemented by a short length of trestling on the left bank.

On the 19th, the column crossed by this bridge, and next day continued the march up the left bank of the river as far as Abu Jisra. On the 21st the march was continued, and the Turks were found to be holding a rear-guard position covering Shahraban, and commanding the Mahrut Canal, a rapid water-way about fifteen yards broad.

Shahraban. Map 10. *Bridging the Mahrut Canal.* Two sections were employed during the 21st and the night of the 21st-22nd in throwing a bridge across this canal about 350 yards up-stream of the old brick road-bridge, which had been demolished by the enemy. No pontoons were yet available, and local materials had to be used, extracted from some mud-hovels close at hand. The work was to a certain extent hindered by shell-fire; and rather a flimsy structure resulted.

The Company remained south of the Mahrut Canal on the 22nd, employed on minor jobs in the vicinity of the 3rd Divisional Headquarters, which had now arrived. The Turks now evacuated Shahraban; and on the 23rd, another trestle-bridge was constructed across the Mahrut Canal, while the 18th (Fd.) Company, 3rd Sappers and Miners, threw two pontoon bridges across the stream in the vicinity.

On the 24th, the Company moved to a point not far north of Shahraban, and immediately started a house-to-house search for bridging materials, which were, as will be seen, urgently required.

The Jabal Hamrin. The Turks were now occupying a position on the Jabal Hamrin, a range of intricate sandstone hills, covered by

the Belad Ruz and Nahrunia Canals. They had destroyed the only existing bridge over the Belad Ruz, and, though pontoon bridges could be thrown across almost everywhere, the height of the banks necessitated much work on the approaches. The bridges actually made can be seen from Sketch Map 10. The 20th Company was responsible for only one bridge, the 18th Company for the remainder.

The British force now consisted of two Infantry Brigades, with Artillery in proportion, and some Cavalry; and, after some days of preparation, the bridges over the Belad Ruz and Nahrunia Canals having been completed, an attack was made on the Turkish position. The 20th Company did not take part in this action, but remained in camp collecting materials and repairing pontoons damaged by shell-fire. The attack was unsuccessful.

Subsequent to this attack a detachment of the Company was sent to prepare for demolition an ancient aqueduct over the Belad Ruz some nine miles east of camp, as it was feared that the Turks might counter-attack from that flank. This aqueduct was demolished on the 29th March. The Turks, however, having effected their withdrawal from Persia, began that night to retire from the Jabal Hamrin. This retirement was followed up by our troops as far as Qizil Robat, where a junction was effected with some Russian Cavalry.

Meanwhile the Company had remained near the Belad Ruz, and had by the 2nd April completed a single-sling bridge over that stream.

APRIL, 1917.

Return to Baghdad. The troops of the 3rd Division were now replaced by units of the 3rd Corps; and the Company marched back with the 9th Infantry Brigade, via Abu Jisra, Baqubah, Coningham's and Cassel's posts, to Baghdad, which was reached on the 7th April. Here camp was pitched on the right bank near the Railway Station; Lieutenant Stables and No. 4 Section rejoined, and Lieutenant Allen, R.E., joined the Company for the first time.

On the 8th, a short move was made to the vicinity of the Masudiyeh Canal, and the Company proceeded to assist No. 4 (Fd.) Company, 1st (K.G.O.) Sappers and Miners to construct a steel bridge. This bridge spanned a gap in the "bund" which ran from Baghdad towards Felujah. It was important to leave a clear water-way through the gap, in order to allow the escape of flood water collecting between the Tigris and Euphrates above Baghdad, and the bridge was necessary to carry the railway to Felujah.

At the same time the erection of a large aeroplane hangar was started.

APRIL, 1917.

The Left Half-Company March to Samarrah. Map 6. On the 16th April, less the right half-company (with Lieutenants Bowers and Otto), the Company took the road again, and accompanied the 8th Infantry Brigade up the right bank of the Tigris, reaching the Median Wall on the 21st, where it was in time to witness, but not to take part in, the Battle of Istabulat. On the 23rd, the Company marched to Samarrah, and went into camp in the vicinity of the Railway Station—an extremely insanitary and fly-ridden spot.

The Adhaim. The Turkish force, which had been defeated at Istabulat, had meanwhile retreated to Tekrit. There was, therefore, no further need for large numbers of troops at Samarrah, and the supply difficulty was acute. Accordingly, the 8th Infantry Brigade, accompanied by the 20th Company—still without the right half-company—marched back by the right bank of the Tigris to Sinijah, and, crossing there by a pontoon bridge, reached Barurah on the 25th, after two trying marches. The role of the Brigade here was to hold the confluence of the Adhaim and Tigris, and secure the communications of the troops of the 13th Division, who were about to advance up the Adhaim and attack the Turkish force on the upper reaches of that tributary.

Remarks on Railway Demolition. A digression perhaps is permissible here, owing to its interest to any who may have to undertake the demolition of a railway. On leaving Samarrah, where they had collected practically all the locomotives and rolling stock of the Baghdad-Samarrah Railway, the Turks decided to render all the engines useless. They, therefore, went down the long line of idle locomotives and blew off the cylinders all along one side. Fortunately for us, they did not notice in their hurry that the engines were facing in both directions; and it was, therefore, easy for our railway engineers to make at least some engines serviceable by replacing damaged cylinders with serviceable ones from the unattacked sides. The line was running again in a surprisingly short time, though the enemy wireless strenuously denied that this could be possible.

Major Boyd proceeded on leave to India from Barurah and Lieutenant Hamilton assumed command.

MAY, 1917.

The left half-company remained in the vicinity of Barurah, throwing up defences for the Sinijah bridge-head, until the 8th May, when it marched with the 8th Infantry Brigade by the left bank to Samarrah, and, having crossed the river there, marched to Sumeichah, some 37 miles down stream from Samarrah, arriving there on the 13th.

A heavy blow was dealt the Company on the last stage of this march, from Balad to Sumeichah, in the loss of 2nd Lieutenant Stables, who was marchingwest of the railway line, parallel to and some miles distant from the column, reconnoitring the country for a new road. He and his escort of 20 men of the 47th Sikhs were attacked by Arabs and all lost their lives. Their bodies were recovered and buried next day.

During the ensuing few days the quarter of Sumeichah, owned by the semi-nomadic tribe responsible for this attack, was demolished. Several Arabs were caught, of whom two were publicly hanged. An expedition organised to surprise the offending tribe, which had taken refuge in the desert about 10 miles west of the railway, was only partially successful. The left half-company formed part of one of the two columns, which moved by night on the enemy camp, and at dawn had reached its allotted position. The other column, which should have barred the retreat of the enemy, did not quite succeed in doing so, and the majority of the tribe escaped, pursued by gun fire, with the loss of a quantity of live-stock and other loot.

After a short stay at Sumeichah, improving the brackish and unpalatable water-supply, and taking up a branch railway line at Khor Tarmiyeh, a few miles away, the half company moved back to Balad on the 20th May.

" Breakdown " Work near the Median Wall. On the 22nd, another move was necessary to a point on the railway-line between the Median Wall and Harbeh, where a serious derailment had occurred. The work of clearing and relaying the line, and replacing a 112-ton engine on the track, under the direction of railway engineers, occupied the half-company until the 31st May, when it returned to the 8th Infantry Brigade camp at Balad. During this period a punitive expedition was undertaken by the Sappers and a detachment of the Manchesters to a village about 4 miles away on the bank of the Tigris, to round up a section of the tribe responsible for the death of 2nd Lieutenant Stables. No men were caught, but some tents were burnt, and 200 head of live-stock and a few hostages from a " friendly " tribe were brought back to camp.

Meanwhile the right half-company under 2nd Lieutenant Otto had arrived at Balad on the 28th May, and the Company was now complete again. Lieutenant Bowers had been transferred to the Irrigation Department.

The right half-company, during the period of its detachment after the completion of the aeroplane hangar, had been employed practically continuously in closing breaches in the " bunds " between Baghdad and Felujah. The work had been hard, and the breaches were only closed after many anxious moments, and with great difficulty.

The Company remained in camp at Balad until the 23rd August, working on water supply and hutting in the 8th Infantry Brigade area, which included Harbeh and Sumeichah. The heat became intense during June and July, and temperatures of 128° F. in the shade were recorded. All troops, however, were provided with E.P. Tents; rations were good, and there was surprisingly little sickness. The men were kept interested by means of weekly Brigade race-meetings or athletic sports, in which the Company was most successful, and polo was organized for the officers.

During this time Sapper officers carried out reconnaissance of the Tigris and its fords, as far up-stream as Istabulat. In addition, as opportunity offered, the men were drilled and trained, and the Infantry instructed in trench warfare. In spite of the extreme heat, therefore, there was little time for idleness.

Lieutenant Nicolle, I.A.R.O., joined the Company on the 11th August.

Istabulat. On the night of the 23rd-24th August, the Company, less Lieutenant Nicolle and No. 1 Section, who were left at Balad to complete water supply work, marched to Istabulat. After preparing water supply for the 8th Infantry Brigade here, work was started on the Istabulat position. This formed part of Sir Stanley Maude's scheme of defence against the Turkish Yilderim (lightning) Army, in the event of the latter attempting to recapture Baghdad. Actually most of the Yilderim Army went to Palestine, and was there destroyed.

On the 7th September, No. 1 Section rejoined from Balad, and on the 13th, Major Boyd, R.E., rejoined and re-assumed command.

The general scheme of the Istabulat position included two tactical bridges over the Dujail Canal to take the heaviest loads. The roadway was carried on trestling, which had to be of a considerable height, and these bridges were not finished until the end of October.

On the 23rd October, the 8th Infantry Brigade received sudden orders to march to Samarrah, owing to the enemy having approached the 7th Division's positions at that place. The Company was left behind at Istabulat, and did not, therefore, take part in the Battle of Tekrit, on the 4th and 5th November.

2nd Lieutenant J. G. Stevenson, R.E., joined on the 24th October.

The time spent at Istabulat was most enjoyable, as the weather became cooler in September, and was delightful in November. The river was close to the camp, and bathing and fishing could be indulged in. Two boats were also made, which afforded a certain amount of amusement.

On the 19th November, having handed over the Istabulat position to the No. 3 (Fd.) Company, 1st (K.G.O.) Sappers and Miners, the Company moved forward to Samarrah, and went into camp on the right bank. Work was immediately started on the Samarrah position, which had been handed over by Engineers of the 7th Division, and continued at full pressure throughout the winter. By March a strong position had been constructed, complete with deep dug-outs, machine-gun posts, observation posts, command posts, dressing stations, and barbed wire.

As the winter advanced, the weather became cold and wet, as many as eleven degrees of frost being registered one night, but all ranks kept fit, and there was no real discomfort.

At exactly midnight on New Year's Eve, the enemy ushered in the last year of the war by dropping a number of aeroplane bombs, but there were no casualties.

FEBRUARY, 1918.

During this period much was done by the Divisional Staff to keep the troops fit and amused. A cross-country race was held in February for Company teams, in which the 20th Company secured first place. A combined team of the 18th, 20th and 21st (Fd.) Companies of the 3rd Sappers and Miners also competed in the final of the Divisional football tournament, but were beaten by a battalion of Gurkhas. In addition, race meetings and horse shows were held; and those in search of amusement could attend an open-air cinema, which gave nightly entertainments near the Company's lines.

MARCH, 1918.

The Samarrah Pontoon Bridge. In March, 1918, half a company was employed for a short time assisting a detachment of a 2nd (Q.V.O.) Sappers and Miners bridge-train on the pontoon bridge, which crossed the Tigris immediately opposite the town of Samarrah. Captain Hamilton had already been for some time in charge of this bridge. This half-company worked well under Subadar Sardar Khan, Bahadur, and was of the utmost assistance. The bridge caused some anxiety, as it was 500 yards long; the stream sometimes ran 8 knots; wind made the bridge rock alarmingly; rain made the roadway dangerous for mules; and the bridge had frequently to be cut, isolating the troops on the left bank from their supplies. Moreover, whenever the bridge was cut, as each of the 100 bays of the bridge used to take up an inch or so at the claws of the baulks, the gap used to widen by nearly half a bay, and the utmost difficulty was always experienced in re-forming the bridge.

MARCH, 1918.

The Company moves to Basrah. On the 21st March, the Company marched to Baghdad, which was reached on the 27th. Captain

Hamilton had meanwhile been transferred to No. 5 (Fd.) Company, 1st (K.G.O.) Sappers and Miners, and 2nd Lieutenant Fratini (who had joined the Company on January 25th) to the Tehri Garhwal Imperial Service Sappers and Miners. The Company proceeded by train to Kut Al Amarah on the 31st, and thence by boat to Amarah, which was reached on the 5th April. Having entrained again, it reached Basrah (Makina Camp) on the 6th. Here Lieutenant Price, I.A.R.O., joined the Company, but was re-transferred to the Sappers and Miners depot when Captain Hamilton rejoined on the 4th May.

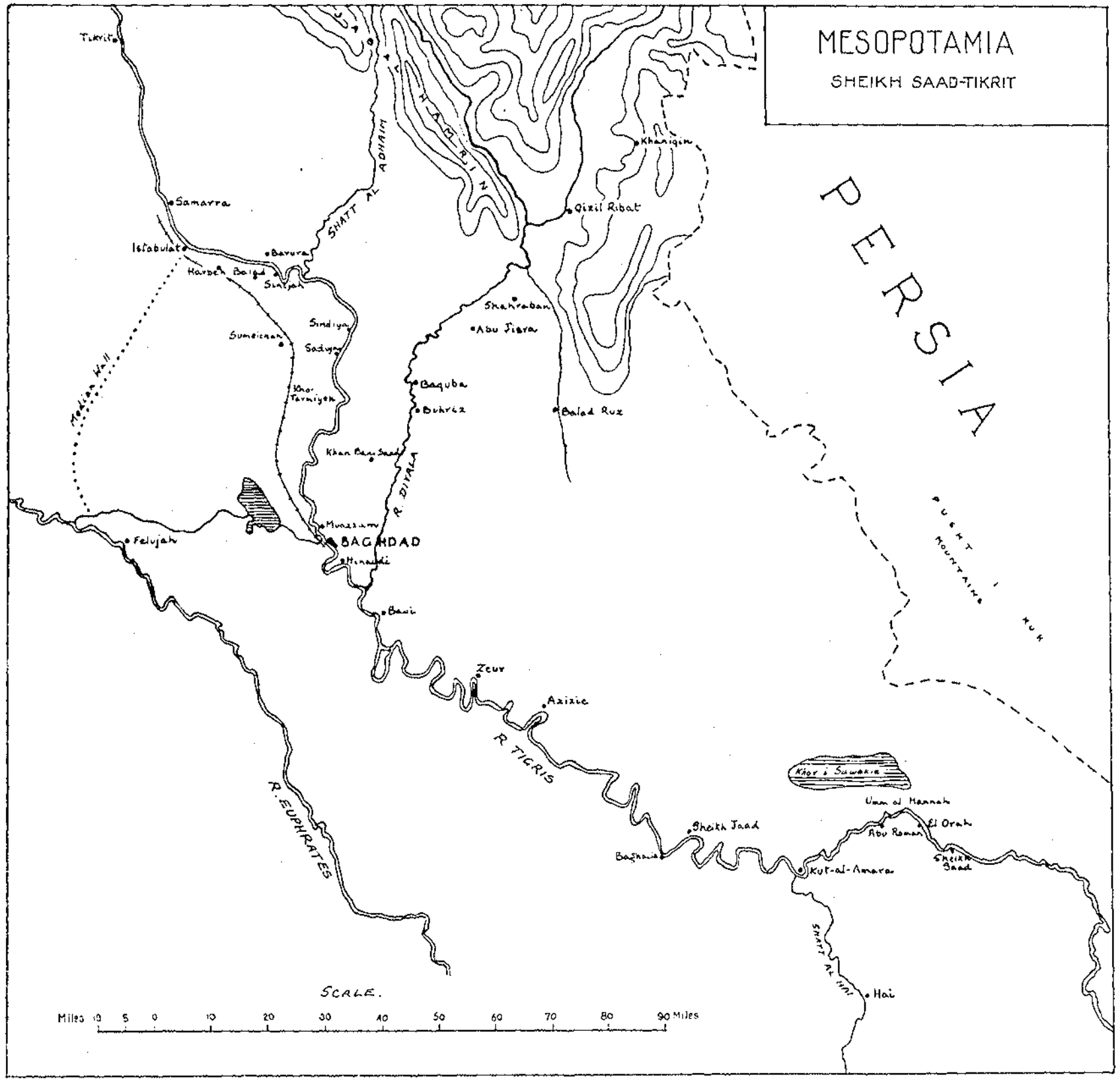
MAY, 1918.

Embarkation for Palestine. A Field Company is never allowed to be idle, and various works were carried out in and around Basrah during the unit's stay there. At length Lieutenant Allen, Sergeant Clark, 29 Indian other ranks, and all the transport, embarked in the S.S. "Theseus," on the 11th May; the remainder of the Company following on the 21st May, first in the S.S. "Bandra," and then, having effected a trans-shipment at Fao, in the S.S. "Danube."

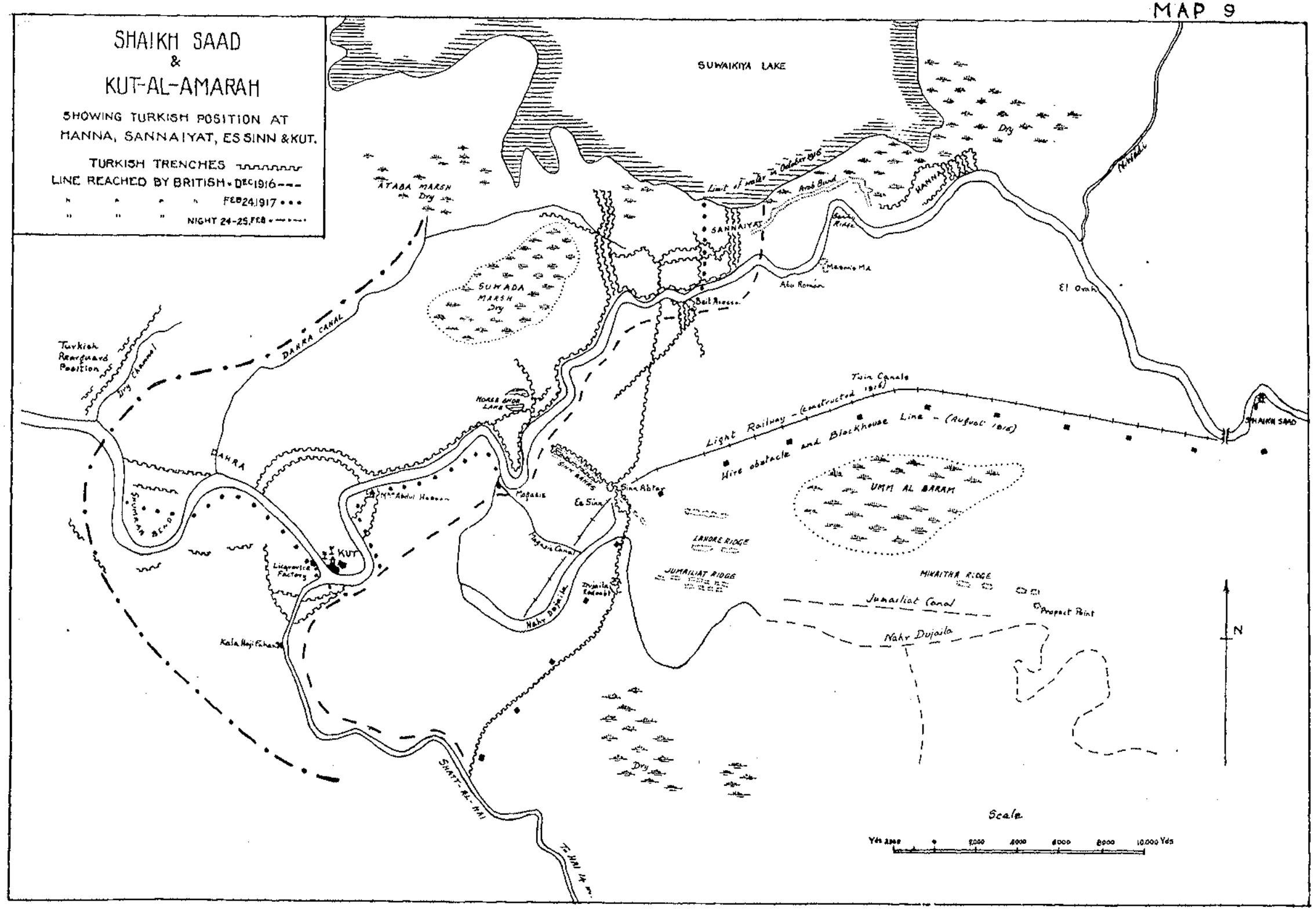
Resumé. The Company's period of service in Mesopotamia which had now ended, can in no wise be compared to its campaign in France. It might, at first sight, appear from this account that warfare in the former country consisted of long periods of inaction, interspersed with a few, and innocuous, bouts of active operations. But, while admitting that actual battle casualties were few, and that, from April 1917 until leaving the country in May, 1918, the Company hardly saw a shot fired in anger, in justice to the men it should be pointed out that Mesopotamia was for them no bed of roses. Officers in the summer of 1916, for instance, might get E.P. tents—the men lived in single fly 160-pounders. In the same year officers could sometimes obtain canteen stores—the men could get no fresh meat or vegetables and rotted with scurvy. But never once did the Company fail to do all, and more than all, that it was called upon to perform; and it left Mesopotamia justly proud of its work, which was well described by Major General Keary in his farewell order quoted below:—

"On leaving the 3rd Division, I desire to record my appreciation of the splendid work done by all ranks of the 18th, 20th and 21st Companies, 3rd Sappers and Miners.

"The 20th and 21st Companies have been with the Division since its arrival in France, and with it have taken part in numberless battles of the first magnitude. Since the day on which they, in conjunction with the 47th Sikhs and 9th Bhopals, captured the village of Neuve Chapelle in October, 1914, to the Battle of Jebel Hamrin in March, 1917, these two Companies have held a

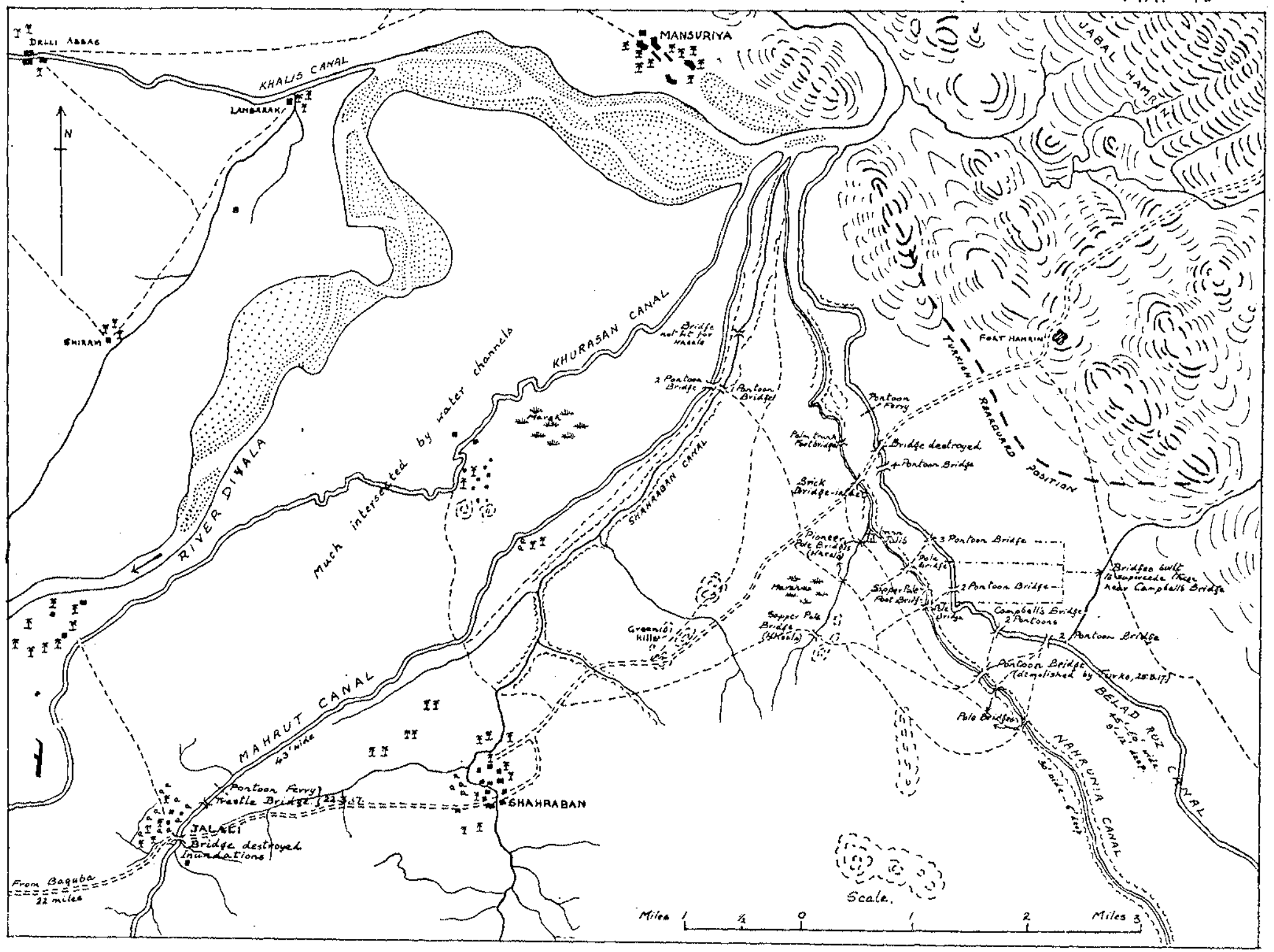

MESOPOTAMIA
SHEIKH SAAD-TIKRIT
PERSIA
Tikrit
Samarra
Istabulat
Baqubah
Bakhriz
Balad Rux
Khaniqin
Qizil Ribat
Shekhraban
Abu Jisra
Sumeicah
Sadiya
Sindiya
Khor Tarniyeh
Khan Beni Saad
Felujah
BAGHDAD
Mahmudi
Bawi
Zeur
Azizie
R. TIGRIS
R. EUPHRATES
R. DIYALA
SHATT AL ADHAIM
HAMRIN
Median Wall
Khor i Suwaikir
Umm al Hannah
Abu Roman
El Orah
Sheikh Saad
Kut-al-Amara
Sheikh Jaad
Baghdad
SHATT AL HAI
Hai
KURDISTAN MOUNTAINS
SCALE.
Miles 10 5 0 10 20 30 40 50 60 70 80 90 Miles

MAP 9


SHAIKH SAAD
&
KUT-AL-AMARAH
SHOWING TURKISH POSITION AT
HANNA, SANNAIYAT, ES SINN & KUT.
TURKISH TRENCHES
LINE REACHED BY BRITISH DEC 1916
" " " FEB 24 1917
" " " NIGHT 24-25 FEB
SUWAIKIYA LAKE
Dry
ATABA MARSH
Dry
SUWADA
MARSH
Dry
DAHRA CANAL
Turkish
Rearguard
Position
Dry Canal
HORSE SHOE LAKE
DAHRA
SUMMAN BEND
KUT
Lieutenant Factory
Kala Haji Fahad
Sin Abbas
Es Sinn
Nahr Dujaila
Dujaila Embankment
Sannaiyat
Hanna
Abu Romain
Bait Aissa
Limit of water in October 1916
Arab Bund
Nahr Dujaila
Twin Canals
Light Railway - (Constructed 1916)
Wire obstacle and Blockhouse Line - (August 1916)
UMM AL BARAM
LANDRE RIDGE
JUMAILIAT RIDGE
MIKAITHA RIDGE
Jumailiat Canal
Nahr Dujaila
Prospect Point
SHAIKH SAAD
SHATT-AL-HAI
N
Scale
Yds 2000 0 2000 4000 6000 8000 10,000 Yds

JABAL HAMRIN - MARCH 1917

MAP 10



record for gallantry and fine fighting spirit second to none. Among other feats may be mentioned that of Captain Arbuthnot and his handful of men, who held the Dujailah redoubt to almost the last man against overwhelming odds.

"To enumerate all the fine achievements of these two Companies would be too long for the purposes of this order. Suffice it to say that wherever and whenever they have been called upon to assist in battle they have responded nobly.

"As Sappers their toil has been unceasing, by day and by night, digging, wiring, bunding, bridging, or sapping, all three Companies have laboured unremittingly under all conditions of enemy's fire, floods, heat, cold, and privations, with the utmost cheerfulness and zeal. No troops could have worked harder or such long hours, while the quality of the work has shown ingenuity and skill of the highest order."

Allowing for a certain hyperbole of language, this was not too high an estimate of the Third Sappers and Miners.

PART III.—PALESTINE.

Voyage to Suez. The S.S. "Danube" was an old ship, badly in need of repair and well packed with troops. Room was found, however, for physical training in the mornings; and detachments of the Company assisted in the stoke-hold. In addition, rowing drill was carried out in Muscat and Aden harbours. After entering the Red Sea, the old engines of the ship developed a habit of breaking down, doing so for the last time in a high wind at the entrance to the Gulf of Suez. Port was made at last, and all ranks were glad to disembark at Suez on the 9th June, whence they were railed the same day to Moascar, just outside Ismailia, where the transport rejoined.

Re-equipping at Ismailia. The Company was now re-equipped on the E.E.F. scales, which differed from those in force in Mesopotamia. For instance, water gear sufficient for a Brigade group was carried by a Field Company in the Egyptian Force, and proved invaluable. During their stay at Ismailia the men were brought into condition by constant route marches, and practice was obtained in loading transport and other duties.

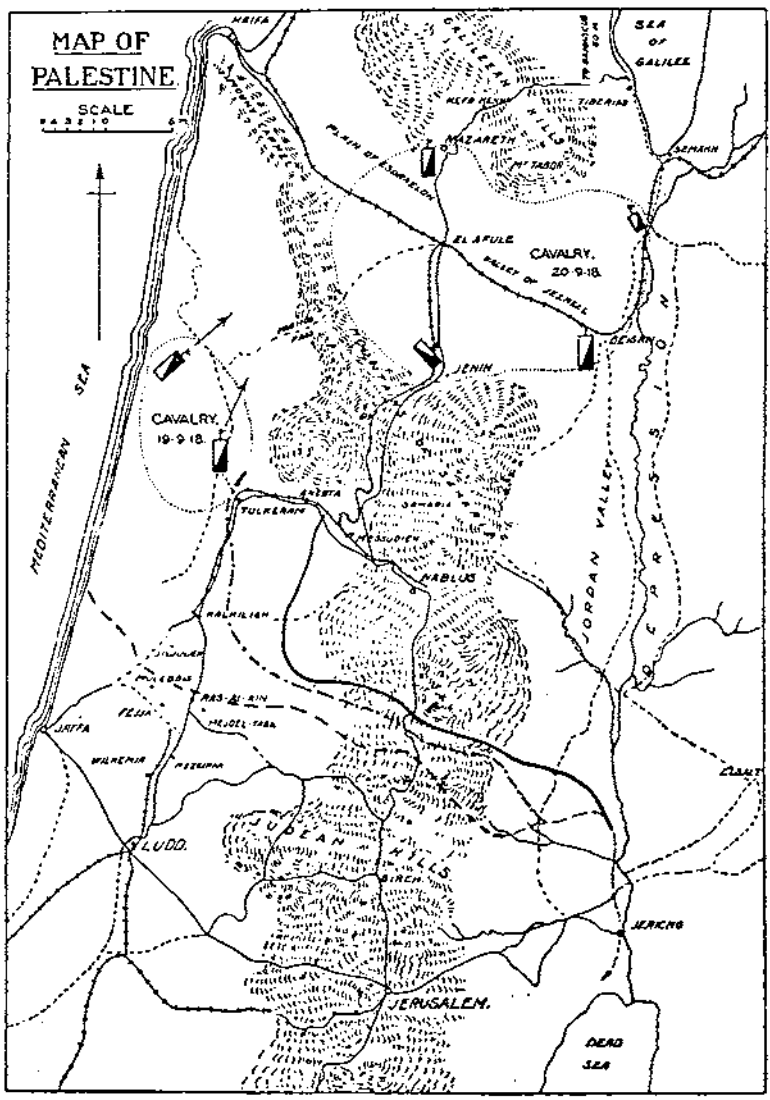
Captain Hamilton now joined the C.R.E. as temporary Adjutant R.E.

JUNE, 1918.

Move to Palestine. Map 11. On the 23rd the unit entrained for Ludd, which was reached on the 24th, and marched thence to camp at Wilhelma, arriving at 10.0 p.m.

The Company worked here on water supply, which included pipe-laying, and the construction of masonry troughs, reservoirs and bath houses, until the 8th July, when the left half-company moved forward and took over the defences in the 9th Infantry Brigade

MAP 11



area, while the right half-company was kept employed in the neighbourhood of Mezeirah on water supply work.

2nd Lieutenant Pirie, I.A.R.O., now joined the Company vice 2nd Lieutenant Stevenson, R.E., who was transferred to the 18th (Fd.) Company, 3rd Sappers and Miners.

Mejdel-Yaba. On the 15th July the Company moved camp again, and concentrated for work on the Mejdel-Yaba sector. Mejdel-Yaba was a conspicuous village on a foot-hill overlooking the plain, which stretched some 10 miles from the mountains to the sea. It was, therefore, a favourite target for the enemy gunners, and Lieutenant Nicolle was slightly injured here, and a sweeper (who had accompanied the unit to France) was wounded by shrapnel. Work on the defences in this area continued by day and night until the 29th July, when the unit moved via Mulebbis, across the river Auja. to Fejja, and took over work from No. 3 (Fd.) Company, 1st (K.G.O.) Sappers and Miners of the 7th Division.

JULY TO SEPTEMBER, 1918.

Fejja. The Company remained in bivouac at Fejja until the 18th September, working continuously on water supply, communications, bridges, and defences. These were designed partly for present needs, but more particularly with an eye to the offensive which was now being prepared. Though this bivouac was in full view of a Turkish O.P. in the foot-hills, it was not shelled and the Company only sustained two casualties: a Sapper killed on night-work and 2nd Lieutenant Pirie slightly wounded.

Captain Hamilton now rejoined from duty with the C.R.E.

The weather, though warm, was delightful; the country was pleasantly green; the Turks were inoffensive; and news of fresh victories in France was received almost daily. So much so, that these two months were perhaps the pleasantest spent by the Company during the war. At any rate, the orange groves of Mulebbis and Jaffa compared favourably with the empty plains of Mesopotamia, and leave to Cairo and civilization could easily be obtained.

SEPTEMBER, 1918.

The Final Offensive. *Map* 11. On the night of the 18th September the Sappers cut gaps in our wire to enable the attack to pass, and on the 19th at 6.15 a.m., immediately the first objectives had been captured, advanced to Kalkilieh, about 6 miles in the rear of the enemy line, and there developed the water supply. A continuous stream of men and animals were watered here during the afternoon and evening.

7 Indian other ranks were wounded this day by the explosion of some Turkish bombs. The camel which stepped on the bombs and ignited them remained unhurt.

20TH SEPTEMBER.

Advance into the Hill Country. Next day, leaving behind Captain Hamilton, the wheeled transport, and No. 3 Section, the Company struck off right handed into the hills, with the advanced guard of the 9th Infantry Brigade, by way of Jiyus and Khan Sir to Baka, where men and animals were watered, and the enemy seen in retreat along a road running north-east from El Funduk. Continuing the advance to Kuryet Hajja, the Company was ordered to occupy a defensive position on some high ground, to withstand a reported counter-attack, which did not eventuate. Having been relieved later by the 93rd Burma Infantry, the Company returned to Kuryet Hajja, and improved the water supply, bivouacking there for that night.

Advance to Nablus. On the 21st the march was resumed past Kuryet Jit along a road strewn with enemy impedimenta, and finally by mountain tracks to Rafidieh, a village on the outskirts of Nablus, overlooking the Vale of Shechem. Here the Company halted until the 23rd, developing the water supply. On the latter date the Brigade Commander of the 9th Infantry Brigade addressed the Company, informing all ranks of their splendid success and thanking all for their share.

The advance had indeed been trying, as it had traversed a rough hill country, with little water and bad roads. For two days the men had existed on their emergency rations and on what they could find. Luckily, large Turkish supplies were found near Nablus.

Meanwhile No. 3 Section and the transport had marched by the narrow valley of the Wadi Azzun, reaching the neighbourhood of El Funduk late on the night of the 20th-21st. They were ordered by the C.R.E. of the 3rd Division to develop the water supplies of the Wady Kana, which lay to the south of the Wadi Azzun, and, having done so, they marched on the 22nd via Kuryet Jit to Zawata in the Vale of Shechem, between Nablus and Samaria.

Messudiyeh. At 2.0 a.m. on the 24th September, the Company marched to Messudiyeh, picking up No. 3 Section on the way, and, after a short stay there, developing water supply and improving roads, moved by Anebta to Kakon, which was reached on the 26th.

The Return to Jiljulieh. It was confidently expected that the 3rd Division would now move up into Syria by the coast road, but at the last moment the orders were changed, and the 7th Division went instead. The Company, therefore, marched back to Jiljulieh, where it remained until the 9th October.

Lieutenant E. H. Silcock, R.E., 2nd Lieutenant Le Quesne, R.E., and 2nd Lieutenant Spence, R.E., joined the Company here.

A further move to Mejdel Yaba was made on the 10th October,

and the Company was thereafter employed, strung out along the Wadi Ballut behind the former British line, salving wire and pickets, and destroying dangerous explosives. Here 10 men were wounded by accidental explosions, 7 of them by the explosion of live bombs on a Gunner wagon. The Company conscientiously salved many miles of barbed wire, which, however, could still be seen in 1920, and probably to the present day, stacked and rusty near Ras Al Ain.

After completing this job, a few days were spent in training, and then the Company returned to Jiljulieh, where Major Boyd and Lieutenant Nicolle left the unit to form new Sapper and Miner Companies at Kantarah. Captain Hamilton now assumed command and Lieutenant Pearce joined from the 18th (Fd.) Company, 3rd Sappers and Miners.

The March to Tiberias. The Company then received orders to accompany the 9th Infantry Brigade to Damascus, and marched on the 25th October, a day ahead of the column, via Tulkeram, Zawata, Jeba, Jenin, El Afule, Reineh (North of Nazareth), to Tiberias, developing the water supply at each halting place. Tiberias was reached on the 4th November. Here orders were received that the 21st (Fd.) Company, 3rd Sappers and Miners, which had suffered badly from malaria at Semakh, at the southern end of the Sea of Galilee, would proceed with the Brigade to Damascus, and that the 20th Company was to relieve them at Semakh, where the 7th Infantry Brigade was camped.

Semakh. Semakh was reached on the 6th, and water supply and other work undertaken there. The 7th Infantry Brigade then received orders to return to Ludd, and the Company marched ahead of them on the 9th by the direct route across the mountains to Kefr Kenna, where arrangements were made to water the Brigade, which marched by Tiberias and arrived on the 10th.

Nazareth. On the 11th November, the Brigade moved into Nazareth, where the Company occupied leaky billets overlooking the town from the north.

Heavy rains now fell and were not deterred by the roofs of the billets from flooding all the rooms, and drenching the occupants. The next few days were, therefore, not enjoyable, notwithstanding the fact that the news of the Armistice filtered through to the Company on the 13th. As far as the Company was concerned there were no armistice celebrations, and the news was soberly received.

Conclusion. Here the war-history must end. There was much work throughout the length and breadth of Palestine, from the

shores of the Sea of Galilee to Beersheba, and from Ludd to the banks of the Jordan, still in front of the Company. The old officers were to go and new officers were to take their places. Nearly two years of exile and discomfort were to elapse before the majority of the men were to see their homes. But yet the spirit of the Comp ny and the Corps lived on. And it was still a fine body of men, worthy successors of the men of 1914, who on the 17th August, 1920, marched proudly across Holkar's bridge, and swung on to the Sapper parade ground, at Kirkee. Here, together with the 21st (Fd.) Company, they were received with all honour by the Corps, at the head of which was Major Paris, their former Company Commander. Just six years before, on that same ground, the Company had promised him that it would strive to add something to the Scroll of Honour of the Third Sappers and Miners. Let this history show whether that promise was fulfilled.

DIVISIONAL ENGINEERS OF THE FUTURE—THEIR DUTIES AND EQUIPMENT.

By MAJOR-GENERAL G. WALKER, C.B., C.B.E., D.S.O.

THIS article has not been written in order to lay down anything dogmatically, but, rather, to raise discussion and to suggest some lines of thought. Everything, including units of Divisional Engineers, has to change to meet the exigencies of changing circumstances. It is interesting in this connection to reflect upon the days when Field Units R.E. were non-existent. It is not so long ago, either. The first units of field character to emerge from the gloom were the Bridging and Telegraph Troops. Then it was realised that the common foot-slogging sapper, whose officers did not wear red shell jackets and sabretaches, also required some means of transporting his technical equipment. The result was the introduction of another mounted R.E. Troop; its vehicles were loaded with R.E. stores and its officers were entitled to wear the coveted jacket and sabretache also.

Let no one think that I am here casting derision on these emblems of military glory. Far from it; they were the outward and visible sign of the military efficiency and grace of the wearers, and I may say that I once wore, with, I hope, becoming humility, a sabretache myself. As time went on, the store Troop was split up between certain foot companies, and the ancestor of the present Field Companies was born.

I think this *resumé* of the evolution of the present Divisional Engineers is interesting, seeing that the "Bridgers" and the Telegraph unit have passed away and that the Field Company, the Cinderella of the three, alone remains extant.

As things have changed in the past, they will assuredly do so in the future. Our problem is, can we foresee how?

2. I take it that no one will quarrel with me when I say that the office of the Divisional Engineer is to apply his art in such a way as to facilitate the other arms in getting to grips with the enemy. That broad definition covers a great many things. It is operative alike in attack and defence, in advancing as well as in retreating. It covers protection from fire and from weather, reconnaissance, communications, both from a constructive and a destructive point of view, and obstacles, as regards both their creation and the overcoming of them.

3. It is desirable, however, to sort out these various duties more definitely. There is one of them which in war is incumbent upon everyone, that is reconnaissance. The Sapper must not confine himself to R.E. reconnaissance, although that affects him possibly most nearly. He must help, with others, to collect, sift, and transmit all the information he possibly can, and he must do this bearing always in mind the sort of news that other people are looking for.

Again, it is now generally, anyhow officially, accepted that the R.E. is only required to do what other people cannot do for themselves. He is, consequently, not expected to dig other people's trenches, nor to put up wire for them. This fact will facilitate, but not reduce, his work, for he will now have time to think about and execute work which was out of his power before.

In view of the above, the work of the Divisional Engineer will probably be of the following classes :

(*a*) Reconnaissance for himself and others.
(*b*) Clearances of fields of fire.
(*c*) Obstacles.
(*d*) Preparation of elaborate defences in stabilised positions
(*e*) Bridging.
(*f*) Demolitions
(*g*) Water supply.
(*h*) Protection against weather.
(*k*) Communications.

4. In modern war, after rapidity of thought and decision, rapidity of action, whether as regards mobility or speed of work, is the first essential. It is no use thinking of the right thing if the other man does it first. The man who gets a move on first has 6 to 4 the best of it in either peace or war.

5. Having spoken generally so far, the next best question is, how are we to produce this speed ? Up to the present we have relied upon man power, manual labour, only, for our work close up to the enemy. We are in exactly the same position in this respect as we were at the time of the Crimean War, or, perhaps, even further back than that. Is it not possible that the progress in the arts of peace has produced things that will strengthen our hands, or possibly enable us to do without them to a large extent ? In short, could we not largely mechanicalize our equipment ? I believe it is possible and also desirable.

6. To go a step further :

(*a*) *Reconnaissance.* Is there any equipment possible that would help the Divisional Engineers to assist the Survey units ? I do not know, but I should like to, as the accuracy, completeness and rapid production of the work of the Survey Department is of immense advantage to the engineer in war.

(*b*) *Clearances.* Is there nothing new in mechanical invention that will supersede the cross-cut saw and axe, or tree cutting by explosives, and which at the same time would be suitable for the equipment of a mobile unit ?

(*c*) *Obstacles.* The most important are tank obstacles. Apart from land mine fields, which it is understood are under consideration, we have not much power at present. Power-driven earth borers, or augers and diggers might help us to produce more substantial overground obstacles than can be produced with mauls and crowbars.

(*d*) *Elaborate Defences.* These connote mining and deep dugouts among other things. Mining may possibly be outside the sphere of the Divisional Engineer, although I have had to do it, both as a Field Company Commander and as a C.R.E. of a Division. Mechanical diggers, as used in civil life, or modified, would be of the greatest help.

(*e*) *Bridging.* It is possible, with the advent of heavy mechanical traffic close up to the front, that the field companies may not be capable of undertaking all the bridging, and that the old " Bridger " may reappear, although shorn of his gay plumes. If not, field companies would be greatly helped if they had some power-driven gear for lifting heavy weights.

(*f*) *Demolitions.* As these were understood in 1914, they were of a most rudimentary character, for we never had a scheme, and even if there had been such a thing we never had enough time. At Mons, the demolitions were carried out under fire, and by the time we got to the Marne we had no explosives left. Military demolitions to be effective must be carefully considered engineer operations, not haphazard efforts to carry out the ideas of the moment. When decided upon, there must be means for rapid preparation and execution. We all know the difficulties of attacking concrete or masonry piers with hand tools. The usual results of any efforts in this direction are unsatisfactory unless a lot of time is available. A power-driven drilling plant seems within the bounds of possibility, and is certainly most desirable. Complicated steel girders are also a tedious and difficult matter to deal with by explosives, and it seems reasonable to suppose that some use could be made of the oxy-acetylene flame in this connection. Again, in repair work it is a question if the use of oxy-acetylene welding is too much for a field company if it could have a portable plant.

(*g*) *Water Supply.* The principal need in a field company is, as far as my experience goes, a power-driven pump in addition to the hand pumps. There ought to be something in civil life to meet this need. We do not look for the perfect article, that probably only exists in some vivid imagination, but we do want something that will " do." Power for driving tube wells would also be a great help.

(*h*) *Protection against the Weather.* This covers huts, canvas shelters, etc., as most of us realise that anything is better than the

sky for a covering in cold or bad weather. It should be clearly understood, however, that troops cannot expect protection of this character from R.E. sources except in stabilised situations.

A field unit now has to compete with this problem by manual labour. Machine saws for cutting scantlings and boarding, and a mechanical feller for cutting down trees, would be a great help. It may be argued that in stabilised positions a field company would not be asked to do this work, which would be carried out by Corps or Army R.E. At the same time the force may be so small as not to merit the name of an Army, or even a Corps: What then? It seems desirable that, anyhow, we should have something of the sort available for issue when wanted.

(*k*) *Repair of Roads.* From the point of view of the Division, this, except in special cases, is a manual labour job, unless corduroy or slab roads are wanted. Repair of road bridges is, however, a different matter, and some sort of lifting gear for launching temporary or repaired girders would be of great use.

We now come to the question of the actual mobility of the units and sub-units. At present we depend upon the horse and wheeled vehicle. Is this good enough? Is the horse sufficiently mobile, and can the wheels go everywhere they are wanted? I am afraid not. I believe we ought to have petrol-driven vehicles which will be independent of roads, for both the sub-units and the stores of the field company—vehicles of the "wheel or track convertible" variety. These vehicles should be designed, not only to carry equipment, but at least some of the men also. This last is a reasonable demand, and will be understood by all who have marched a company of sappers from daylight to dark, and then had to put them to work all night. I often wondered how the men did it. If we are to get the ideal rapidity we must have rapid-moving transport, some means of conserving the energy of the men, and such power-driven mechanical devices as are possible, so that the men can do their work, when they get to it, with speed.

7. The suggested petrol-driven vehicles could provide the power when at rest for the power-driven tools. If fitted with winches, and possibly a light jib, it would be all to the good. In addition to the vehicles mentioned above, the provision of motor-cycles and side-car combinations would be of great assistance, even in the present horsed units.

8. For work at night, the provision of a small lighting set with shaded lights would be a great help in each section of a field company. While on the subject of electricity it is worth considering whether W/T. in a field company is desirable. Before 1914 we had visual signalling, and we sent men to the Army Signal School to be trained. A man waving a flag or flags during the Great War was more likely

to qualify for promotion to the next world than in this, so the flags were put away. If inter-communication was necessary before the war, it would appear to be not less so now.

9. My critics will say, no doubt, that this article is largely "hot air;" that nothing is recommended with any exactitude. It was not intended to be exact. What is intended is that we should, as a Corps, start thinking about these things. It is easy enough to write about the past and one's own experiences. It is not so easy to look forward and think clearly about the future. Engineering science is advancing every day, and it is our duty to see how we can use the inventions of the day for the good of the service. It is "up to" all of us, no matter how young we may be, to use our opportunities in this matter and to give expression to the results of our enquiries in writing, presumably in this journal. It is no use to be afraid of being derided for our youth and inexperience. Youth is a disease that Nature quickly cures. Youth also has this great asset: It is buoyant and usually free from the trammels of tradition. Moreover, the youth of to-day will have to run the show in the future; in fact, the future lies with them. I hope that these lines, if they do nothing else, will raise discussion and will induce people to bring forward definite technical suggestions, not mere pious aspirations, on this most important subject. It is not *lèse majesté* to do this. The military authorities have to make the decisions, but it is not *ultra vires* for any one to make suggestions that may help those decisions to be wisely made.

THE DISEMBARKATION AT ALHUCEMAS BAY.

The following account of the Spanish disembarkation in the bay of Alhucemas (Morocco) in September, 1925, is abridged from a detailed narrative by Captain D. Joaquin Ramirez y Ramirez, of the Engineers of the Spanish Army, in his Corps magazine for the month of March, 1926.

By LT. COL. R.E.M. RUSSELL, C.B.E., D.S.O., R.E.

THE operation had been considered since 1912, and would probably have been carried out in 1921 had not the disaster of Annual in that year paralysed the Spanish campaign until the entry of France into the combat, in 1924, gave it new life.

The plan adopted in 1925 was drawn up by General Gomez Jordana, and was destined to take place in June of that year, but for various reasons was postponed until the beginning of September.

The objective was Axdir, the seat of the Rifi Government, and the hinterland of the Alhucemas coast, which was the main landing place for Rifi war material obtained from Europe.

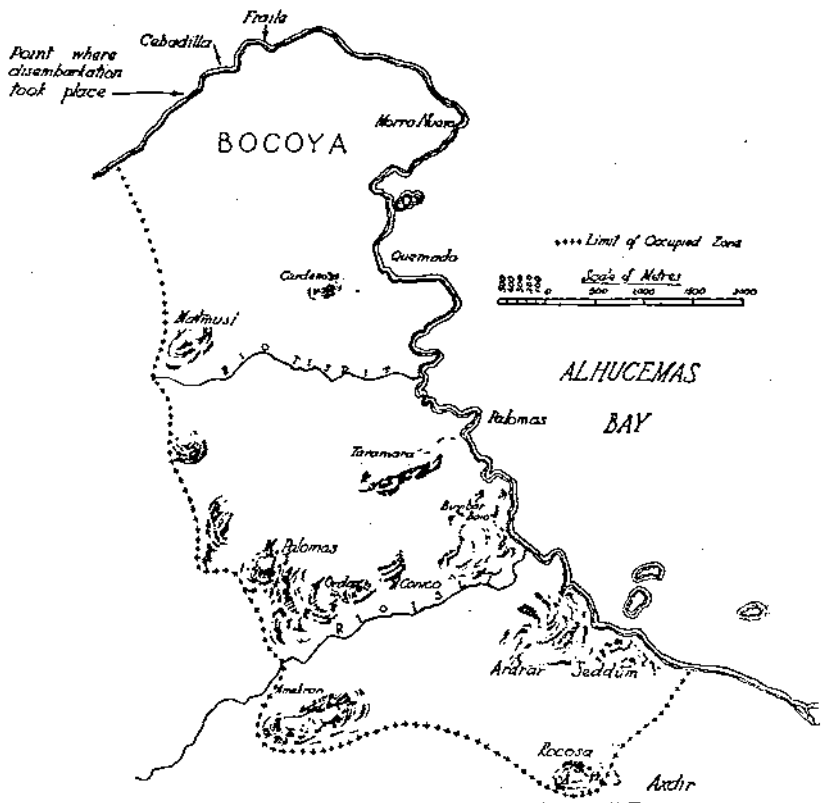
Information as to the Rifi strength and dispositions is not given, but is stated to have been good. They appear to have been in considerable strength, well supplied with artillery and machine guns, and their morale was high. They were expecting attack from the shores of the bay of Alhucemas, and had disposed most of their available infantry and artillery accordingly, as well as having laid submarine mines off the coast, and obstacles on the land approaches.

The Spanish plan was to effect two simultaneous surprise landings on opposite sides of the Bocoya peninsula, which was well outside the prepared zone; establish a base on the peninsula, and advance as rapidly as possible by successive bounds to Rocosa, Adrar Seddum, and the final objective at Axdir; the real landings being preceded and accompanied by bombardments and simulated landings at places within the zone of the enemy's preparations. In addition to the factors of surprise and tactical security thus aimed at, it was hoped to obtain the easy submission of the Bocoya tribe, who were not on the best of terms with the Beni Warrigel. Adverse factors were the scarcity of water, supplies and fuel on the Bocoya peninsula, with the consequent danger in the event of prolonged bad weather on the exposed beaches.

Forces available.—The Spanish forces available for the landings totalled 20,000 of their European and Native Regular Army, Foreign Legion ("Tercio"), and native auxiliaries; including 24 guns 7 c/m. or (2.8 inch) and 10 5 c/m. (or 4.2 inch), 100 machine guns, 133

light automatics and 40 trench mortars. The whole organized as a "division" of two "columns" (or brigade groups) of all arms. The Spanish and French Fleets provided a battleship, 4 cruisers, 6 gunboats, and minor craft, mounting in all 28 30.5 c/m. (12 inch), 35 15 c/m. (6 inch), 22 14 c/m. (5.5 inch), 46 10 c/m. (4 inch), and 23 7.5 c/m (3 inch) guns, in addition to anti-aircraft and machine guns.

Air force units, Spanish and French, naval and military, provided theoretically 100 aeroplanes and some kite balloons, but the author states that the number which actually materialized were "much fewer."



The 1st Divisional Commander, General Sanjurgo, was in supreme command of all the naval, military, and air forces until the disembarkation of the troops was effected, when the command of the fleet was to revert to the Admiral.

The two columns (or Brigades) were known as :—

(*a*). The Melilla Column, under the command of General Fernandez Perez, allotted to the landing projected at Cala del Quemado (on the S.E. side of the peninsula).

(*b*). The Ceuta Column, under the command of General Saro, allotted to the landing at La Cebadilla (on the N.W. side of the peninsula).

The columns were of approximately equal strength, each having about :—

4 Battalions European Regular Infantry (including one Marine Battalion).

2 Battalions Foreign Legion (Tercio).

3 Battalions Native Regular Infantry.

1 Mounted unit of Native Auxiliaries.

1 Dismounted unit of Native Auxiliaries.

1 Artillery Group (1 six-gun battery 2.8 in. mountain guns and 1 six-gun battery 4.2 in mountain howitzers).

3 Companies Engineers.

Medical and Administrative Services.

Each Brigade was given 11 transports and a hospital ship. In addition, the Ceuta Brigade (Cebadilla landing) had an extra ship carrying a battalion and bridging stores. A reserve hospital ship accompanied the Melilla Brigade.

In each Brigade 2 transports carried ammunition, 2 engineering stores, 2 camping material, 2 supplies, 1 animals, 1 medical stores, and 1 reserve stores.

For transport from ship to shore there were available for the two landings, in addition to the ships' boats, 26 motor-driven "K" lighters (those actually used by the British forces on Gallipoli), each carrying 300 men, drawing about 4 feet of water, and provided with a let-down bow extending some 26 feet.

The engineers carried material for constructing 8 landing piers, each about 100 feet long, as well as pontoons. (The Spanish pontoon is of steel construction, and fairly good in rough water).

One hundred civilian professional boatmen were allotted to each landing.

Rifle Ammunition.—200 rounds on the man.
50 per rifle in the lighters.
250 in boats.

A reserve of one million rounds per Brigade was carried in the reserve store ship.

Light Automatics.—2,000 rounds with the gun, 400 per gun in the lighters, 1,600 per gun in the reserve store ship.

Machine Guns.—7,800 rounds with the gun, 3,900 in the lighters, 11,700 in the reserve ship.

Grenades.—4,000 hand and 5,000 rifle per brigade, of which 250 were in each lighter and the remainder in reserve.

Artillery Ammunition.—(Nature not stated ; presumably all H.E.) per 7 c/m. gun, 144 with the battery, 432 in reserve store ship ; per 10.5 c/m. Howitzer, 112 with the battery, 336 in reserve store ship.

Field Engineer Stores.—4 sandbags on each Infantry soldier, 1,000 in each lighter.

Sandbags and obstacles for 5 company posts and 12 platoon posts for each brigade in the reserve store ship.

Two 45 c/m. searchlights per brigade.

Water.—Each man carried two water bottles. The lighters and boats carried their own receptacles full and in addition 170 portable carriers, each holding 14 litres, 400 tanks, each of 300 litres and 2,000 casks of about 20 litres. Three tank boats of from 70 to 300 tons capacity were available. Pontoons were also counted on as supplementary water carriers if not otherwise required. A special engineer water-boring unit was provided for each brigade.

Supplies.—Two days preserved meat and bread on the soldier, 2 days ditto on the lighters, 14 days full rations on the transports. The cooking apparatus of the transports was supplemented by the field kitchens of the troops on board. Live cattle were carried, of which it was necessary to slaughter 80 per day to provide the ration of 200 grammes per day, the animals of the country being very small and in bad condition.

Fuel Wood for two days was to be landed with the troops, and provision was made for supplementing the scanty shore supply for a period of up to 3 months after landing.

Forage.—Five kilogrammes of barley and 3 of hay were to be landed for not exceeding 400 animals per brigade at the original landing, comprising only the horses of commanders, staffs, and despatch riders; and the mules of batteries, ambulances and mobile parks. The balance of the total 1,100 animals per brigade being landed later. Three months' forage was provided.

Camping Material.—Nine thousand bivouac shelters, 600 bell tents, 40 marquees, 2 portable electric light sets for hospitals.

Medical Stores.—Units carried their complete medical and surgical equipment, which was to be replenished from a medical park with each brigade.

Two surgical sections, with a hospital for 300 beds, accompanied each brigade.

Two launches, each towing two lighters, conveyed casualties from shore to each brigade hospital ship for evacuation to the base hospitals of Ceuta, Melilla, or Malaga.

Signals.—Divisional headquarters were equipped with a pack W/T. set, and with pack visual and telegraphic and telephonic apparatus.

Each brigade had 3 small W/T. sets, 7 V/T. stations, and 30 kilometres of cable with 20 L/T. or telephone stations.

Maps.—An aerial survey had been completed during the previous month and was issued in the form of squared maps (no details given).

EXECUTION.

The troops embarked on September 5th at Melilla and Ceuta, immediately the loading of the stores and material was completed,

and put to sea on the 6th, escorted respectively by the French and Spanish Naval Squadrons.

Feint bombardments of Wad-Lau and Sidi-Dris (35 kilometres to the east of Axdir) were carried out on the evening of the 6th. On September 7th, while the Spanish Squadron was bombarding the shores of Bocoya, the French Squadron again bombarded Sidi-Dris, making a feint at landing from boats and lighters covered by a smoke screen.

During the night of the 7th-8th the transports and lighters remained some six miles off the shore, and the morning of the 8th found the whole convoy drifted by the current some 30 miles to the westward of Cebadilla, and so scattered that the bulk of it was not re-united until the 9th, some vessels not having rejoined even by then.

Meanwhile, events further to the west (Kudia-Tahar) had made it necessary to be prepared to detach a portion of General Fernandez Perez's (Melilla) brigade in that direction. The projected landing at Cala del Quemado was, therefore, abandoned, and all landings ordered to be effected on the N.W. shore of the Bocoya peninsula, the beach at El Fraille being chosen for General Perez's brigade.

The weather was fine, but the beaches were found cramped, with a rocky bottom, and very exposed to the swell. Enemy artillery fire compelled the transports to keep several miles out to sea. The slow speed of the "K" lighters delayed matters considerably until orders were given for them to be taken in tow by gunboats to within 1,000 metres of the coast, the G.O.C. himself leading them in a torpedo boat. The actual landing was almost unopposed (thanks to the success of the feints) except by long range artillery fire, and the first troops got ashore about noon on September 8th, after having had to wade more than waist deep. Pushing on in the face of slight opposition they occupied the high ground of Morro Nuevo (where they captured artillery), on the left, and Ixdain on the right, reaching the first under features of Malmusi. They were subsequently withdrawn from these advanced positions as positions in rear were consolidated.

Fine weather prevailed on the 8th, 9th and 10th, and enabled most of Saros brigade to disembark successfully with water and stores at Cebadilla, but things did not go so smoothly at El Fraille beach. Here the combined effect of artillery fire, which caused 200 casualties, shortage of launches, and faulty co-operation between navy and army (which the author states is always to be expected in his country) seriously delayed the disembarkation of Perez's brigade. Added to these, a "Levanter" gale sprung up on the 11th, sinking several lighters and suspending landing operations. The most serious immediate result was an acute shortage of water on shore, which necessitated the reduction of the ration to two litres

per day, and precluded the possibility of landing any of the horses or mules. Only two days' rations had been landed.

The brigade at Fraille had to be subsisted temporarily on the brigade at Cebadilla, immobilizing both, congesting the approaches, attracting enemy artillery fire.

The enemy seized the opportunity to attack strongly on the Spanish left on the 11th, 12th, 13th and 19th, causing heavy casualties.

It was not until the 22nd that it was possible to land the transport horses and mules. By this date over 1,000 casualties had been incurred.

A general advance in five columns had been planned for the 23rd, but was delayed by the failure of the air forces to co-operate as ordered (no reasons given). Its inception at a late hour on that date was only due to the refusal of one of the column commanders (Colonel Goded) to obey the divisional order to wait for the aeroplanes. The objectives were gained at the cost of 650 casualties, and it became possible to use the beach at Cala del Quemado, as originally planned, in substitution for that of El Fraille.

Water fit for horses and mules was discovered, but the drinking water situation became critical during another gale from the 25th to the 27th, when the water barges were unusable and almost wrecked. The ration on the latter day was reduced to ½ litre, but the passing of the gale enabled the ration to be again raised to two litres, at which figure it was subsequently maintained. The distribution of water presented much difficulty, involving free fights at times.

The remainder of the operation proceeded slowly but with complete success, and the final objective at Axdir was attained on the 2nd October.

Summary.

The author considers the plan to have been extremely well conceived, and the secrecy and methods of deception which were practised to have achieved complete success. He states that the preparations showed a great advance on the previously proverbial Spanish lack of foresight.

In addition to the material difficulties (which were great) the Chief Command had to deal with the lowered morale produced by previous lack of success in the Morocco Wars and by the example of the Allies' failure at Gallipoli.

The exemplary courage and initiative which all ranks displayed paid a high tribute to the manner in which the Commander-in-Chief succeeded in overcoming these difficulties.

TRANSLATOR'S COMMENTS.

(1). The hybrid organization of the two "Brigades," and the grouping of more than twelve major units under one Brigade Staff, appears to be open to criticism: the more so as the brigades appear to have been again reorganized into five "Columns" directly they were ashore and the advance commenced.

(2). The theoretical advantages of having Navy, Army, and Air Force directly under one commander do not seem to have materialized in this case, as the convoys failed to arrive within 30 miles of their destination at the appointed time, the capabilities and limitations of the lighters do not seem to have been realized, and the Air Force entirely failed to put in an appearance when required.

(3). The arrangements for landing and distributing water were evidently inadequate, and water discipline lacking.

WAZIRI WAYS.

By BRIGR.-GENL. H. H. AUSTIN, C.B., C.M.G., D.S.O.

The Waziris probably require little introduction to British readers. When the tremendous clash of arms that had resounded throughout the civilized world for more than four years began to die down in Europe, Palestine, Mesopotamia and East Africa, this devastating war that was to end war was certainly not regarded in that light by our wild neighbours dwelling along the North-West Frontier of India. During the titanic struggle the Waziris had not been drawn into the ambit of the conflagration. Indeed, their hands had then been freer than usual to embark on a policy of pin-pricks, so dear to the Waziri soul, by raiding into British territory and indulging in other acts of defiance towards the long-suffering *Sirkar*, whose attention was already more than fully occupied by the enormity of the demands made on its resources. Thus, for a time, Waziri misdeeds did not meet with the prompt and condign punishment they so richly merited, and it was left to a later period, when the Government was less embarrassed by the events of the Great War, and another war with Afghanistan on the top of it, to resume the old, old story of marshalling forces to excise the Waziri thorn in the flesh.

And so for some years past the Indian Government has once again been engaged in the subjugation of these recalcitrant mountaineers, elusive will-o'-the-wisps who inhabit a region of great physical difficulties abounding in rugged ridges and deep rocky gorges, radiating from lofty ranges whose summits attain an altitude of 11,000 feet above sea level. It is probably due in some measure to the barren, inhospitable character of the country, and its lack of resources, that the Waziri in general, and the Mahsud clan in particular, look elsewhere to supplement their means of existence. Naturally brave and warlike, they have no scruples in depriving their less warlike neighbours of what they do not themselves possess, by fierce forays carried out with rapidity and daring. Hence one may suitably apply the term Ishmaelite to this race, for their hands are certainly against every man's and most men's against theirs. Nevertheless, the Waziri does not seem weighed down by this distinction ; and doubtless still inwardly believes, what for many generations he openly boasted, that he alone of all the Afghan clans remains free.

Be that as it may, the whole tribe are thieves, and are proud of their prowess in the subtle art of plunder. Unless paid blackmail, they light-heartedly raid their neighbours and carry off cattle, camels, rifles and ought else they can lay their hands upon, for all is grist to

their mill. Yet hospitality is regarded as a prime virtue among them; and each village has a place set apart for guests, who are welcomed at dawn and at sundown, when prayers are being said, after which they are provided with food. The cost of hospitality is borne by the whole village; and the Waziris claim they have no poor, because whenever a family is brought low, the rest of the clan subscribe to re-establish it. Thus there is little incentive for the Waziri to quit his wild home to seek his fortune elsewhere, so he remains in the hills all the year round, which is probably one of the reasons why he does not enlist readily in the ranks of the Indian Army.

Though the Waziris profess to recognize no other law or will but their own, they do observe some form of rough justice in their intercourse with each other, by inflicting money fines for murder and other assaults within the community. Whether the scale has been materially affected by the present high cost of living in western lands, I do not presume to say; but formerly the pecuniary compensation for the murder of a fellow-tribesman was Rs. 1,300, half of which had to be paid in hard cash, and the other half in produce and commodities, including two girls, valued at Rs. 100 each. The fine for the murder of a woman was half that for a man. Other gradations followed; the loss of a limb or eye by a sword cut being valued at Rs. 500; that of the nose Rs. 250, and of an ear Rs. 100. Gun-shot and dagger wounds were less highly fined, and ranged from Rs. 100 to Rs. 50, according to whether death was to be apprehended as a result of the wound or not. Adultery was punished by the man having a foot cut off with a blunt knife or saw; and victims to this barbarous method of mutilation, furnished with a wooden leg, are to be seen at times stumping the steep hill-sides of Waziristan. Drastic measures are probably necessary to maintain the sanctity of family life, for marriage is chiefly a matter of barter, the cost of a bride being from Rs. 60 to Rs. 150.

Plundering, as already stated, is one of the main professions of this turbulent tribe; not from each other, be it noted, for some honour still obtains among these notorious thieves. But woe betide any wayfarer who happens to fall into the clutches of these marauders, if of an alien tribe. Apart from the plains of the Derajat, perhaps the most fruitful raiding grounds of the Waziris lie beyond their southern borders, along the gorges of the Gomal river and lower stretches of the Zhob. This is wild country, indeed, where gangs of *budmashes* can find ready means of concealment amid the broken hills and rocky recesses of sombre vales. From these convenient lairs they can issue forth on unsuspecting travellers in the twinkling of an eye, and retire again to such haunts with their ill-gotten booty long ere their sudden swoop is reported to posts designed to protect the peaceful pedestrian, and trader bearing goods along these infested highways. Thus there

is little love lost between the Waziris and those whom they delight to victimize, so long as the chances of success are entirely in their favour.

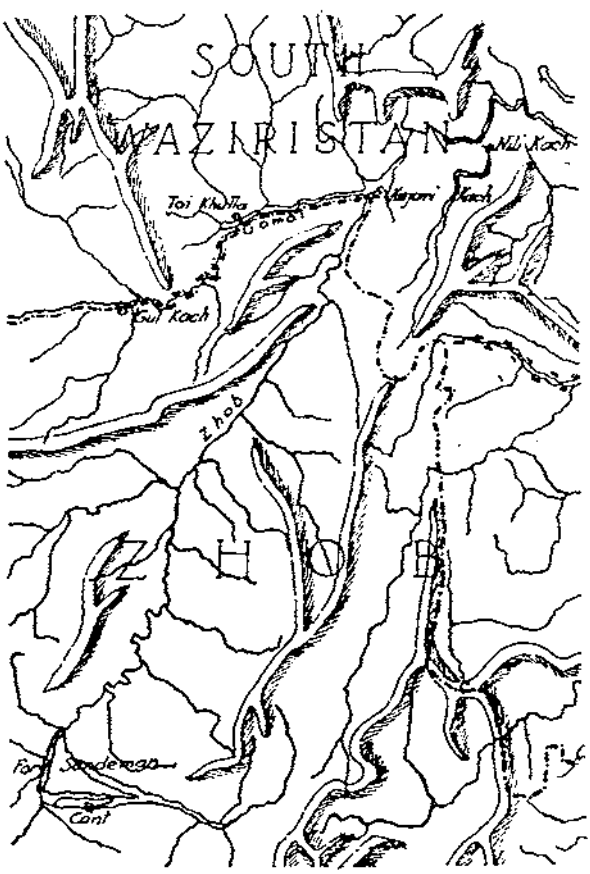
This Ishmaelite outlook of the Waziri has, not unnaturally, caused him to be regarded as an enemy of mankind by other tribes dwelling within raiding radius ; and by those accustomed to traverse certain routes, leading to and from India, located within striking distance of Waziri territory. Of such routes the gorge of the Gomal, above its junction with the Zhob, is that perhaps most frequented by caravans proceeding from Afghanistan to the plains of India ; and this was for generations a happy hunting resort of Waziri bands. Between the Powindahs—migratory Ghilzai warrior traders whose homes are about Ghazni—and the Waziris, it was a matter of war to the knife ; for the Waziris never lost an opportunity of raiding Powindah caravans when these twice annually passed along the Gomal, going to and returning from India. How great were the possibilities of loot during these migrations will be realized when it is stated that about 50,000 of these nomads, men, women and children, accompanied by thousands of camels, and immense flocks of goats and sheep, entered the Dera Ismail Khan district every year by the Gomal route from the middle of October to the middle of December, and returned to Ghazni between the 20th March and 10th May. It is small wonder, then, that these Powindahs marched through the Gomal in regular armies, and were well organized to meet the attacks of Waziris, who were always on the look-out to cut off stragglers, and to fire on the Powindahs from the heights dominating the tracks followed. Hence, a captured Waziri experienced short shrift at the hands of the Powindahs. He could expect no mercy, so usually resigned himself to his fate —a simple one, for he invariably had his throat cut as though he were a sheep, and was buried on the spot without any further to-do.

The Powindah method of dealing with the hated Waziri was gentlemanly in comparison with the punishment meted out to him when caught by Nasirs. In each case death was all he could hope for ; but he now had the questionable pleasure of observing, as a preliminary, a metal plate being heated in a fire until it became nearly red hot, the purport of which he quite well understood. The executioner would then step forward, and with one deft stroke of his keen tulwar completely behead his victim. Before the blood had time to gush forth, the hot plate would be clapped on to the trunk by assistants ; whereupon the Waziri's headless body would perform a series of leaps and bounds to beat of drum and the undiluted glee of Nasirs gathered round to watch its antics. Thus was the Waziri loved by those of his co-religionists he was ever ready to murder and spoliate.

Near by, but mostly beyond our border in this area, a large tract of country is occupied by the powerful and warlike Sulaiman Khel tribe. A considerable number of them also migrate to India in the cold weather, and there they behave well enough, though they have

the reputation of being very rough customers outside British territory. Between them and the Waziris, likewise, there is perpetual strife, and they seldom lose the chance of waylaying each other when the odds are about four to one in favour of the assailants. The origin of this feud is connected, by report, with the possession of the Wana plains, whereon good grazing grounds, always a contentious subject, are to be found at certain seasons of the year. In any case, Waziris and Sulaiman Khels loathe and have a wholesome dread of each other; and will never willingly travel in twos and threes in the vicinity of the other's habitat, particularly along the Gomal.

Now, it had long been known by the authorities in India that the Gomal was a great highway of Afghan traders (Powindahs) between Central Asia and India. Yet, up to 1889 our knowledge of this important line of communication was extremely scanty, resting almost entirely on native information. In the summer of that year Sir Robert Sandeman had proceeded on a tour down the Zhob from



Loralai, near Quetta, and reached its junction with the Gomal at Kajuri Kach. Thence he continued over the Gwaleri Kotal (pass),

avoiding impassable gorges in the Gomal—the name given to the now combined streams—and descended to the lower stretches of the river about Nilai Kach, from which point he followed it to the plains of India.

But the upper course of the Gomal, flowing generally E.N.E. from the Zermelan plain to join the Zhob, was still but vaguely known. Indeed, from where the river entered the gorges that commence at the eastern extermity of that plain, and continue throughout the intervening twenty-five miles to Kajuri Kach, it remained a *terra incognita* until surveyed by a section of the Zhob Valley Railway Survey expedition between December, 1890, and February, 1891.

As we were the first Europeans to visit and spend some weeks in these wild gorges, to which Waziri territory extended, it was hardly to be expected that we would escape the attention of these profesional thieves during our sojourn along their border. In anticipation of the possibility that the Waziris might prove troublesome whilst survey work was in progress, a covering force of the 3rd Baluchis, and a squadron of the 12th Bengal Cavalry, occupied a standing camp at Gul Kach, out on the Zermelan plain, a short distance up-stream of the western entrance to the Gomal gorge.

The survey section numbered five British officers, some forty armed Pathan *khalassies* to assist in outdoor work, and an escort of fifty men of the 3rd Baluchis under an Indian officer. Our transport consisted almost entirely of hired camels with their owner attendants. The covering force and the survey section had marched together to Gul Kach from Apozai (now Fort Sandeman) through some fifty miles of very broken hilly country, the abode of many bad characters, before we reached the bank of the Gomal on the 14th December, 1890. A certain amount of preliminary survey work had to be done in the vicinity prior to undertaking the gorge portion of the Gomal; and it was then decided that we should proceed down-stream to Kajuri Kach, and work upwards from the Gomal-Zhob junction to Gul Kach, thus carrying on the survey being done by another party below the junction.

To march down the Gomal gorge with camel transport from Gul Kach was impracticable, owing to its precipitous character in the first six or seven miles; so Lieut. (now Col. Sir Henry) MacMahon, the Political Officer with the force, arranged that we should follow the Powindah track on the left bank of the Gomal. This led over the Kandori Pass, avoiding the upper gorges and striking the river again at Toi Khula, where the Toi stream, draining the Wana plains to the north, joined the Gomal about midway to Kajuri Kach. The country on the left bank hereabouts was temporarily treated as though under the sway of the Amir of Afghanistan, pending the final agreement as to the boundary—arrived at some years later; for which reason MacMahon enlisted the services of twelve Sulaiman Khels to

accompany us, as sureties for our safety whilst traversing this corner of then foreign territory.

These twelve gentlemen were fine specimens of humanity, their leader standing not less than 6′ 3″ in height, and broad in proportion. Although mostly of villainous mien, they inspired a certain amount of confidence in their ability to protect our sanctity, by reason of their warlike appearance, for they were little short of perambulating arsenals. Each carried a *jezail*, the old flint-lock musket, and a goodly supply of powder in flasks, and spherical bullets for the medieval weapon. A curved tulwar, flint-lock pistol, and an evil-looking dagger, all thrust into his waist-band, reinforced his armament. So long as they remained on our side of the river, and under the sheltering care of the battalion and cavalry, never was seen such a stout set of fellows. But, alas, when the small survey party left the covering force, waded across the Gomal, threaded its way through a mass of clay cliffs and mounds, the reputed site of the ruins of Sodom, and turned away up the broken slopes leading to the Kandori Kotal, our sureties began to lose a good deal of their pristine swagger. Further, their superb chief contrived to give us the slip, whilst we clambered with our camels towards the summit of the Kandori; because, we subsequently learnt, his brother had been shot dead thereabouts by the Waziris only a short time before. He deemed it prudent, therefore, to return to MacMahon at Gul Kach, leaving his colleagues to escort us to our destination. Presumably he felt he would be unable to curb his desire for revenge should we, unhappily, stumble across a few Waziris during our trek ; and thus create complications.

The Kandori clearly boasted an evil reputation, for stone cairn memorials to those who had met with violent deaths were seen at intervals. Just irregular heaps of stones they were, at the side of the track, and on these the interested traveller tossed his quota as he passed, in accordance with his sympathies. Thus was homage paid to any particular cairn that appealed to him as indicating the spot where a Waziri, or one of the many enemies of that tribe, had bitten the dust. Our good Sulaimans, however, successfully steered our course for some sixteen miles through very intricate country, and landed us on the bank of the Gomal, which we again forded and pitched camp on a small plot of stony ground overlooking the river. And here we spent a most miserable Christmas next day, as it blew great guns straight off the snows, and rained heavily.

Having got us so far, the Sulaimans began to work themselves up to a very nervous state. They clamoured to be permitted to return to Gul Kach, averring that if they proceeded farther to Kajuri Kach they would inevitably be cut to pieces by the Waziris when they set out thence for their homes. In short, they endeavoured to convince us that we would be guilty of little less than murder did we persist

in taking them on. But the arrangement agreed upon at Gul Kach, and for which these men had been paid in advance, was that they should accompany us as far as Kajuri Kach—now only twelve miles distant. So they were held to their bargain, and marched with us down the gorge—here practicable for camels by frequently crossing from one bank to the other—to the Zhob-Gomal Junction.

There it certainly was not encouraging for them to learn that a band of forty or fifty Waziris were on the rampage in the neighbourhood, and had recently been giving trouble to the other railway survey party working in the Gomal gorges below the junction of the rivers. These rogues had, a day or two before, waylaid the Hindu *syce* of one of the officers, eased him of such cash as he had about him, stripped him naked save for a thin cotton shirt, and sent him back to camp in this *negligé* attire. It was the depth of winter and bitterly cold, so the *syce* failed to appreciate the untimely jest quite to the same extent as the witty Waziris. A few nights later the rascals went one better, and succeeded in extracting a Snider carbine from under the head of one of the Pathan *khalassies*, who was sleeping on it by way of a pillow in a tent in the same camp. The slumberer was not even awakened, nor the theft discovered until the morning, which suggests consummate skill on the part of the thief.

And this state of things was going on within a few miles of a Waziri Levy post, which had been established on the right bank of the Zhob, overlooking its junction with the Gomal, for the specific purpose of protecting travellers from the depredations of other Wazari thieves. I say "other" advisedly, for the subsidised Waziri occupants of the post, numbering about sixty in all, were not above taking part in plundering exploits themselves when favourable opportunity offered, as I will presently show.

Our camp at Kajuri Kach was pitched on the right bank of the Gomal, in the angle formed by the junction of the two rivers, the stony bed of the Zhob being 500 to 600 yards wide here, and that of the Gomal from 300 to 400. Looking straight across the former, one saw the Levy post perched on a small plateau well above the highest known flood level of the waters' meet—a very formidable affair a short way down the gorge below the junction. The post consisted of a small rectangular enclosure, surrounded by high loop-holed walls of mud, with a tower at one corner and a bastion at the diagonally opposite one. Quarters were provided for the Waziri levies round the base of the four walls, the roofs forming the banquettes for manning the loopholes above. On the ground floor of the tower was a small sitting room and a tiny bathroom, for the use of British inspecting officers, with a sleeping apartment on the storey above. These upper and lower rooms were supplied with windows in the outside walls, protected by bullet-proof shutters of wood and iron.

When sent back with a few men on one occasion from our camp at

Toi Khula, to complete some work between that place and Kajuri Kach, I had the privilege of spending one night with Mr. Donald, a Political Officer, in this cramped post. This had for the nonce to furnish shelter for something like 120 men—including the Waziri garrison—and a number of horses and mules belonging to Donald's and my parties. Now Donald had spent his life, almost from boyhood, on this frontier, could speak Pushtu like a native, and what he didn't know about the tribes on our border wasn't worth knowing. Nevertheless, little did he trust our presence, and that of the Waziri levies, as likely to render the post sacrosanct from outside attention by night. So the lower room bullet-proof shutter was closed whilst we partook of our evening meal and occupied that chamber before retiring to rest. And it was not until we were about to get into bed in the upper room, and had "doused the glim," that its bullet-proof shutters were re-opened to admit fresh air during the night.

In justice to the Waziri levies, however, it is only right to say that during the week our survey section was camped at Kajuri Kach we were not molested by thieves. Our work then required camp to be moved some six miles up the Gomal to Shaidan, about midway to Toi Khula. Here the ground consisted of a series of small flat terraces, covered with black boulders and stones; and camp was pitched on one such terrace facing the river, with another terrace rising in rear and more or less defilading the camp from the hills and cliffs behind. Whilst in these regions all our camps were laid out with great precision, almost to the fraction of a foot. They were rectangular in shape, the long sides approximately fifty yards in length, and the shorter thirty. Tent ropes overlapped round the entire perimeter save for the 10-foot roadway running through from one long face to the other; and just outside their entrances two sepoys' tents were pitched. Camels, mules and ponies were tethered close alongside one face of the camp under the eyes of the guard-tent; and sentries posted at short intervals around the whole circumference.

Taking the terrain to be traversed into consideration, it would seem no easy matter, then, for the most skilful of thieves to penetrate the cordon of sentries, and worm his way into the camp itself through all those tent ropes, particularly as we officers had about half a dozen excellent watch-dogs sharing our tents. Yet, shortly before the moon rose on the 5th January, a Waziri managed to get right into the camp, and absconded with the entire change of kit belonging to one of the *khalassies*. He was certainly seen disappearing with his loot, and was fired on by a Baluch sentry; but his approach to the camp was never spotted, and he got clean away.

This exploit was apparently intended merely as a feeler; for a couple of nights later, when the sky was much overcast, a thunderstorm threatening, and rain falling at intervals, the camp was aroused at about 2 a.m. by the report of a rifle, followed by several others.

We hastily donned our *poshteens*, buckled on belts with revolvers, snatched up our rifles and dived out of our tents, imagining a night attack at least was taking place. The Pathan *khalassies* were all at their alarm posts in no time, manning the gaps between the tents; so seeing all in readiness here, we moved over to the guard-tent in rear of camp, whence the sepoys were still firing. There we learnt that some thieves had managed to creep between the sentries and enter the camp, making a bolt for it under fire when detected. A few apparently had not fled very far, and were ensconced behind several big rocks a short distance in front of the guard-tent; for, out of the darkness, stones were being pitched towards the tent and falling around us. It was senseless waste of ammunition to fire into the inky blackness, where one could not see ten yards beyond one; more particularly so since the thieves were absolutely safe behind the rocks. Thus, a British officer sallied forth with ten sepoys to rout the rogues out from their lair. Not a sign of them did he see, however; but during his twenty minutes' patrol he stumbled upon a large packing case, containing two dozen boxes of 100 cheroots each.

The thieves had abstracted this from the Swiss Cottage mess-tent, which occupied one corner of the perimeter, in continuation of the officers' line of tents. In spite of sentries and alert dogs close by, the expert rascals had boldly removed the case between the line of sentries and out into the void, though it must have required a couple of men to carry it owing to its bulk; and all this was done without making a sound or disturbing a soul in camp! Seemingly they had only abandoned their booty when fire was opened upon those of their confederates detected within the camp.

To appreciate fully the skill of the feat, it might be added that were you and I to attempt to pick our way across that stony terrace in the broad light of day, with no encumbrance of any sort and grass sandals on our feet, we would surely raise a rare commotion. This would be magnified to so great an uproar in the silence of the night as could not fail to awaken the most somnolent of sentries. There were ten watchful guardians distributed round the whole camp—a perimeter of about 300 yards, including the animal lines. The thieves must have passed within ten or fifteen yards of sentries, therefore, both coming and going.

One was faced by somewhat novel conditions in dealing with these Waziri thieves; and the sentries did not at first realize that the pitching of stones towards the camp from the darkness without formed an integral part of the plan of campaign of these rogues. Having worked their way to within striking distance of the camp, so to speak, even the cat-eyed Waziris were unable to locate the position of the sentries, for these were generally concealed in shallow pits round the perimeter, and did not tramp backwards and forwards along regular beats. Thus it was essential to mark down the sentry

posts before further action could be safely embarked upon, and so the stone-throwing ruse was employed.

A sentry first subjected to the insult of having stones pitched in close juxtaposition to his place of concealment would probably imagine he had been spotted, and was being made a foolish target of; indignantly, or nervously, as the case might be, he would reply by loosing off his rifle in the direction whence he thought the stones were being thrown. This was precisely what the Waziri wanted. The bullet would pass harmlessly over his head, and he had got that sentry's position marked down to a foot. Now for the next; and so on.

So far so good; but the Waziri had yet to traverse the intervening stony space between himself and the line of sentries, in order to enter the precincts of the camp—unheard and unobserved. How did he do it? It is obvious his movements must now be very deliberate; but time was of little concern to these patient and persistent thieves, so long as they ultimately achieved success after the sentry had been lulled into a sense of security by stones ceasing to drop in his vicinity. Then, in a low crouching attitude, the serpent would crawl from his cover, and softly clear away with his hands the stones from the spot to which the next foot was to be advanced. Thus, step by step, with infinite caution and quite noiselessly, would he creep closer and closer, and finally pass between the line of sentries in the pitchy darkness of the night selected for his operations. The cold, calm courage of the rogue, and his inexhaustible patience, would be worthy of much admiration were these attributes directed into less reprehensible channels. But Waziri cunning, unfortunately, occasioned us much food for reflection during the period we were subjected to frequent night alarms by reason of it.

It did not take long, however, to instil into the minds of the sentries that, by replying to the stones falling around them, they were but giving their positions away; so that little weakness of theirs was quickly quashed. We officers, too, often sat up for hours hidden in pits, hoping for a chance to take toll of these nocturnal prowlers; but they were wary birds, and evidently endowed with the gift of acute scent, as well as of uncanny sight in the dark, for not one of us ever obtained a glimpse of, or shot at, these pests. Yet, shortly after abandoning the vigil, in order to snatch a few hours' sleep before the labours of another day, we would probably hear the "bang, bang" of rifles, and be out of our beds again in a trice to investigate the cause.

The causes were sometimes comic, but generally the reverse. From considerations of space I can give but one example of each from various experiences at Toi Khula camp, to which we moved from Shaidan on the 9th. January. Our camp was pitched on the same site as that of Christmas Day, on a flat plot of high ground on the right bank, and immediately overlooking the river, down to which the

drop there was precipitous; whilst in the stony bed was a considerable patch of tall reeds through which the icy stream flowed. Directly opposite the camp, on the left bank, a huge, conglomerate cliff rose sheer out of the river bed to a height of 200 or 300 feet, and indicated the place just below which the Toi entered the Gomal.

The first night or two after settling down into a new camp we were usually left alone; or so it seemed, though the Waziris probably employed the time in getting a hang of our fresh arrangements before embarking on operations. Their initial exploit at Toi Khula was announced by terror-stricken shouts in the small hours of the morning by one of the *khalassies*. These were sufficiently blood-curdling to convince one that the wretched man was having his throat cut; and promptly caused us to hasten to his aid, and that of the other occupants of his tent. There it came out that the man had been a prey to bad nightmare, and awoke with a jerk to feel someone trying to pull the socks off his feet! This proved too much for him in his disorganised condition, and he let out the succession of yells which had thrilled light sleepers throughout the camp. The Waziri was seen by no one, so must have slipped away in the darkness when the *khalassi* gave tongue. He departed without the socks, but with a couple of useful cooking-pots to compensate him for having to continue his tramps bare-footed.

Another week of almost nightly alarums and excursions followed; and then we had the mortification of losing the only rifle captured by Waziris throughout these series of séances. It was taken from one of our Baluch regulars, too, which made the circumstances all the more regrettable, being entirely due to the man's own stupidity. It had been a clear, frosty moonlight night, a priceless boon to the wanderer in wild regions, and had passed peacefully. But just after the moon set the sentry sought to warm himself at a fire some ten yards distant from his post, and which, incidentally, had no right to be burning. Instead of taking his rifle along with him, however, the oaf laid it against a rock and sauntered off to the fire. In the twinkling of an eye two Waziris sprang up from nowhere; and whilst one discharged his pistol at the now unarmed sentry the other seized the Martini, and both were gone again like a flash. Before any of the other sentries could get a shot at them, they disappeared over the low rocky cliff into the bed of the river, and vanished into the reeds through which they gained the opposite bank unseen. A picquet was at once sent in pursuit, but small chance had it of overtaking the rascals, to whom every recess along the course of the Toi was as familiar by night as by day. So that Martini was struck off the strength, and the sentry conveyed under arrest to regimental headquarters at Gul Kach, to be tried by court-martial for gross carelessness.

After a time we grew somewhat weary of the ceaseless attentions

of the Waziris by night, though we seldom saw any sign of them by day whilst engaged on survey work in the gorge. Ultimately, we determined to circumvent the ruffians by constructing low stone walls round the entire camp perimeter. These light structures were too high to step over, and so flimsily erected that any portion interfered with came down with such a clatter as could not fail to give the alarm at once. This simple device was quickly run up, thanks to the fine crop of stones always to hand, and proved most efficacious. Henceforth, during the next month in the Gomal, we usually enjoyed undisturbed nights in bed; and the Waziri thief had to admit defeat.

Whilst at Toi Khula, we were sufficiently distant from Kajuri Kach to afford no semblance of protection to travellers supposed to derive that boon from the presence of the Levy post at the junction of Zhob and Gomal; and it has been shown that between Waziris and Sulaiman Khels much ill-feeling existed, to put it mildly. Thus it was not altogether surprising to be appealed to one day, when at work near Toi Khula, by two bedraggled, woe-begone Sulaimans who had hurried up-stream to pour forth their tribulations in our ears. Their story was to the effect that a party of seven of them, with twenty-one camels, were returning from India to their homes carrying 300 rupees in cash, and valuable goods loaded on their animals. Relying on the protection of the Government post, they pitched their camp for the night on the site we had occupied a short while before, and retired to rest after their evening meal.

They were roused from their slumbers some hours later by finding themselves surrounded and set upon by a band of about forty Waziris. Before they had time to defend themselves, two of their number were killed, two others wounded, and their entire possessions looted by the gang, who promptly decamped with their booty. The Sulaimans were prepared to swear that the Waziri levies of the post were concerned in the attack, for they recognised dogs that belonged to men in the post. One could readily believe it; but it was difficult to see what was to be done in the matter beyond furnishing the disconsolate victims of the outrage with a letter to the Political Officer of these parts, in the hope that he might be able to redress their wrongs.

The Waziris had certainly got the better of the Sulaimans by treachery this time; and one could but trust that Sulaimans elsewhere along this turbulent border had simultaneously scored off the Waziris. The ebb and flow of opportunity probably worked out pretty well "all square" between these inveterate enemies, year in and year out; and as we were but peaceful toilers in this land of strife and unrest, repression of Waziri ways was entirely outside our province.

BATTLE HONOURS OF ROYAL ENGINEER UNITS (continued).

N.B.—"LYS" COUNTS AS AN EXTRA HONOUR FOR PARTICIPATION IN ANY OF THE BATTLES FROM ESTAIRES TO SCHERPENBERG.

ESTAIRES. 9TH-11TH APRIL, 1918.

Unit.	Formation.		Remarks.
FIRST ARMY.			
ARMY TROOPS.			
"D" Special (Cylinder) Co.	XI Corps	E.	
"F" ,,	XV ,,	,,	
No. 1 Special (Mortar) Co.	XI ,,	,,	
No. 3 ,,	XV ,,	,,	
134th Army Troops Co.	IX ,,	,,	Attached 25th Div.
145th ,,	XV ,,	,,	
552nd ,,	XI ,,	,,	
556th ,,	XV ,,	,,	
1st Aust. ,,	IX ,,	D.	Attached 25th Div.
251st Tunnelling Co.	XI ,,	E.	
XI CORPS.			
56th Field Co.	3rd Div.	N.E.	
438th ,,	,,	D.	
529th ,,	,,	N.E.	
400th ,,	51st Div.	E.	
401st ,,	,,	,,	
404th ,,	,,	,,	
419th ,,	55th Div.	,,	
422nd ,,	,,	,,	
423rd ,,	,,	,,	
476th ,,	61st Div.	,,	
478th ,,	,,	,,	
479th ,,	,,	N.E.	
23rd ,,	1st Div.	,,	
26th ,,	,,	,,	
409th ,,	,,	,,	
XV CORPS.			
455th Field Co.	29th Div.	E.	
497th ,,	,,	,,	
510th ,,	,,	,,	
210th ,,	31st Div.	N.E.	
211th ,,	,,	E.	
223rd ,,	,,	N.E.	
207th ,,	34th Div.	E.	
208th ,,	,,	,,	
209th ,,	,,	,,	
224th ,,	40th Div.	,,	
229th ,,	,,	,,	
231st ,,	,,	,,	
7th ,,	50th Div.	,,	
446th ,,	,,	,,	
447th ,,	,,	,,	
105th ,,	25th Div.	N.E.	
106th ,,	,,	,,	
130th ,,	,,	,,	
57th ,,	49th Div.	E.	
456th ,,	,,	N.E.	
458th ,,	,,	,,	

SIGNALS.

ESTAIRES. 9TH-11TH APRIL, 1918.

Unit.	Formation.	Remarks.
First Army Signal Co.		N.E.
L. Corps Signal Co.	XI Corps	E.
3rd Divl. Signal Co.	,,	,,
51st ,,	,,	,,
55th ,,	,,	,,
61st ,,	,,	D.
1st ,,	,,	N.E.
P. Corps Signal Co.	XV Corps	D.
29th Divl. Signal Co.	,,	E.
31st ,,	,,	D.
34th ,,	,,	E.
40th ,,	,,	,,
50th ,,	,,	,,
25th ,,	,,	N.E.

MESSINES, 1918. 10TH-11TH APRIL, 1918.

Unit.	Formation.	Remarks.
SECOND ARMY.		
ARMY TROOPS.		
No. 2 Special (Mortar) Co.	IX Corps	E.
134th Army Troops Co.	,,	,, Attached 25th Div.
167th ,,	,,	,,
1st Aust. ,,	,,	,, Attached 25th Div.
184th Tunnelling Co.	,,	N.E.
No. 351 E. & M. Co.	,,	D.
No. 8 Foreway Co.	,,	,, No diary.
IX CORPS.		
63rd Field Co.	9th Div.	E.
64th ,,	,,	,,
90th ,,	,,	,,
81st ,,	19th Div.	,,
82nd ,,	,,	,,
94th ,,	,,	,,
105th ,,	25th Div.	,,
106th ,,	,,	,,
130th ,,	,,	,,
97th ,,	21st Div.	N.E.
98th ,,	,,	,,
126th ,,	,,	,,
11th ,,	33rd Div.	,,
212th ,,	,,	E.
222nd ,,	,,	N.E.
57th ,,	49th Div.	,,
456th ,,	,,	E.
458th ,,	,,	,,
XV CORPS		
455th Field Co.	29th Div.	N.E.
497th ,,	,,	D.
510th ,,	,,	N.E.
207th ,,	34th Div.	N.E.
208th ,,	,,	,,
209th ,,	,,	D.

SIGNALS.

MESSINES, 1918. 10TH-11TH APRIL, 1918.

Unit.	Formation.		Remarks.
Second Army Signal Co.		N.E.	
E. Corps Signal Co.	IX Corps	D.	
9th Divl. Sig. Co.	,,	E.	
19th ,,	,,	,,	
25th ,,	,,	,,	
21st ,,	,,	N.E.	
33rd ,,	,,	,,	
49th ,,	,,	D.	

HAZEBROUCK. 12TH-15TH MARCH, 1918.

Unit.	Formation.		Remarks.
FIRST ARMY.			
ARMY TROOPS.			
"D" Special (Cylinder) Co.	XI Corps	E.	Fleming's Force 51st Div.
"F" ,,	XV & Can. Corps	N.E.	
No. 1 Special (Mortar) Co.	XI ,,	E.	Attached 51st Div.
No. 3 ,,	XV ,,	N.E.	Within area but not employed.
134th Army Troops Co.	IX Corps	N.E.	
145th ,,	XV ,,	D.	
167th ,,	IX ,,	N.E.	
230th ,,	XI ,,	E.	
235th ,,	VIII ,,	N.E.	
552nd ,,	XI ,,	E.	
556th ,,	XV ,,	,,	
557th ,,	VIII ,,	N.E.	
1st Aust. Army Troops Co.	IX ,,	,,	
170th Tunnelling Co.		,,	
171st ,,	IX Corps	,,	
184th ,,	IX ,,	E.	
251st ,,	XI ,,	N.E.	
255th ,,	IX ,,	D.	No diary.
3rd Can. ,,	IX ,,	E.	
I. CORPS.			
56th Field Co.	3rd Div.	E.	
438th ,,	,,	,,	
529th ,,	,,	,,	
9th ,,	4th Div.	,,	
406th ,,	,,	,,	
526th ,,	,,	,,	
419th ,,	55th Div.	N.E.	
422nd ,,	,,	,,	
423rd ,,	,,	,,	
XI CORPS.			
59th Field Co.	5th Div.	E.	
491st ,,	,,	,,	
527th ,,	,,	,,	
7th ,,	50th Div.	,,	
446th ,,	,,	,,	
447th ,,	,,	,,	
400th ,,	51st Div.	,,	
401st ,,	,,	,,	
404th ,,	,,	,,	
476th ,,	61st Div.	,,	
478th ,,	,,	,,	
479th ,,	,,	,,	

HAZEBROUCK. 12TH-15TH MARCH, 1918.

Unit.	Formation.		Remarks.
XV CORPS.			
2nd Field Sqn.	2nd Cav. Div.	D.	
455th Field Do.	29th Div.	E.	
497th ,,	,,	N.E.	With 88th Inf. Bde.
510th ,,	,,	E.	
210th ,,	31st Div.	,,	
211th ,,	,,	,,	
223rd ,,	,,	,,	
11th ,,	33rd Div.	,,	
212th ,,	,,	N.E.	
222nd ,,	,,	,,	
207th ,,	34th Div.	,,	
208th ,,	,,	D.	
209th ,,	,,	N.E.	
224th ,,	40th Div.	E.	
229th ,,	,,	,,	
231st ,,	,,	,,	
1st Aust. Field Co.	1st Aust. Div.	,,	
2nd ,,	,,	,,	
3rd ,,	,,	,,	

SIGNALS.

HAZEBROUCK. 12TH-15TH APRIL, 1918.

Unit.	Formation.	Remarks.
First Army Signal Co.		N.E.
"A" Corps Signal Co.	I Corps	E.
3rd Divl. Signal Co.	,,	,,
4th ,,	,,	,,
55th ,,	,,	D.
L. Corps Signal Co.	XI Corps	,,
5th Divl. Signal Co.	,,	E.
50th ,,	,,	,,
51st ,,	,,	,,
61st ,,	,,	,,
P. Corps Signal Co.	XV Corps	D.
29th Divl. Signal Co.	,,	E.
31st ,,	,,	,,
33rd ,,	,,	D.
34th ,,	,,	E.
40th ,,	,,	,,
1st Aust. ,,	,,	,,

BAILLEUL. 13TH-15TH APRIL, 1918.

Unit.	Formation.		Remarks.
SECOND ARMY.			
ARMY TROOPS.			
No. 2 Special (Mortar) Co.	IX Corps	E.	
42nd Army Troops Co.	XXII ,,	N.E.	
133rd ,,	XXII ,,	,,	
134th ,,	IX ,,	E.	
136th ,,	XXII ,,	D.	No diary.
167th ,,	IX ,,	N.E.	
235th ,,	VIII ,,	E.	
557th ,,	VIII ,,	,,	
1st Aust. ,,	IX ,,	,,	
171st Tunnelling Co.		,,	

BAILLEUL: 13TH-15TH APRIL, 1918:

Unit:	Formation:		Remarks:
184th Tunnelling Co.	IX Corps	N.E.	
255th ,,	IX ,,	E.	No diary.
3rd Can. ,,		,,	
No. 351 E. & M. Co.	XXII Corps	D.	
No. 8 Foreway Co.	,,	,,	No diary.
No. 9 ,,	,,	,,	No diary.
IX CORPS.			
81st Field Co.	19th Div.	E.	
82nd ,,	,,	,,	
94th ,,	,,	,,	
105th ,,	25th Div.	,,	
106th ,,	,,	,,	
130th ,,	,,	,,	
207th ,,	34th Div.	,,	
208th ,,	,,	,,	
209th ,,	,,	,,	
57th ,,	49th Div.	,,	
456th ,,	,,	,,	
458th ,,	,,	,,	
467th ,,	59th Div.	,,	
469th ,,	,,	,,	
470th ,,	,,	,,	
97th ,,	21st Div.	N.E.	
98th ,,	,,	,,	
126th ,,	,,	,,	
XXII CORPS.			
63rd Field Co.	9th Div.	E.	
64th ,,	,,	,,	
90th ,,	,,	,,	
XV CORPS.			
455th Field Co.	29th Div.	N.E.	
497th ,,	,,	E.	With 88th Inf. Bde.
510th ,,	,,	N.E.	
11th ,,	33rd Div.	,,	
212th ,,	,,	E.	
222nd ,,	,,	,,	

SIGNALS.

BAILLEUL. 13TH-15TH APRIL, 1918.

Unit.	Formation.		Remarks.
Second Army Signal Co.		N.E.	
"E" Corps Signal Co.	IX Corps	D.	
19th Divl. Signal Co.	,,	E.	
25th ,,	,,	,,	
34th ,,	,,	,,	
49th ,,	,,	,,	
59th ,,	,,	,,	
21st ,,	,,	D.	
33rd ,,	XV Corps	E.	
V Corps Signal Co.	XXII Corps	D.	
9th Divl. Signal Co.	,,	E.	

KEMMEL (FIRST BATTLE). 17TH-19TH APRIL, 1918.

Unit.	Formation.		Remarks.
SECOND ARMY.			
ARMY TROOPS.			
No. 2 (Special) Mortar Co.	IX Corps	N.E.	
42nd Army Troops Co.	XXII ,,	E.	
133rd ,,	XXII ,,	N.E.	
134th ,,	IX ,,	E.	
136th ,,	XXII ,,	D.	No diary.
167th ,,	IX ,,	N.E.	
235th ,,	VIII ,,	E.	
557th ,,	VIII ,,	,,	
1st Aust. ,,	IX ,,	,,	
171st Tunnelling Co.		D.	
184th ,,	IX Corps	N.E.	
255th ,,	IX ,,	D.	No diary.
3rd Can. ,,	IX ,,	E.	
No. 9 Foreways Co.	XXII ,,	D.	No diary.
IX CORPS.			
81st Field Co.	19th Div.	E.	
82nd ,,	,,	,,	
94th ,,	,,	,,	
105th ,,	25th Div.	,,	
106th ,,	,,	,,	
130th ,,	,,	,,	
11th ,,	33rd Div.	,,	
212th ,,	,,	,,	
222nd ,,	,,	,,	
207th ,,	34th Div.	,,	
208th ,,	,,	,,	
209th ,,	,,	,,	
57th ,,	49th Div.	,,	
456th ,,	,,	,,	
458th ,,	,,	,,	
467th ,,	59th Div.	,,	
469th ,,	,,	,,	
470th ,,	,,	,,	
455th ,,	29th Div.	N.E.	
497th ,,	,,	E.	With 88th Inf. Bde.
510th ,,	,,	N.E.	
XXII CORPS.			
63rd Field Co.	9th Div.	E.	
64th ,,	,,	,,	
90th ,,	,,	N.E.	
225th ,,	39th Div.	,,	
227th ,,	,,	,,	
234th ,,	,,	,,	
97th ,,	21st Div.	,,	
98th ,,	,,	,,	
126th ,,	,,	,,	

SIGNALS.

KEMMEL (FIRST BATTLE). 17TH-19TH APRIL, 1918.

Unit.	Formation.		Remarks.
Second Army Signal Co.		N.E.	
E. Corps Signal Co.	IX Corps	D.	
19th Divl. Signal Co.	,,	E.	
25th ,,	,,	,,	
33rd ,,	,,	,,	
34th ,,	,,	,,	
49th ,,	,,	,,	
59th ,,	,,	,,	

SIGNALS.

KEMMEL (FIRST BATTLE). 17-19TH APRIL, 1918.

Unit.	Formation	Remarks.
Y. Corps Signal Co.	XXII Corps	D.
9th Divl. Signal Co.	,,	E.
39th ,,	,,	N.E.
21st ,,	,,	,,

KEMMEL (SECOND BATTLE). 25TH-26TH APRIL, 1918.

Unit.	Formation.	Remarks.
SECOND ARMY.		
ARMY TROOPS.		
42nd Army Troops Co.	XXII Corps	E.
133rd ,,	XXII ,,	D.
134th ,,	IX ,,	E.
136th ,,	XXII ,,	D.
138th ,,	II ,,	N.E.
141st ,,		,,
235th ,,	VIII ,,	,,
289th ,,	II ,,	,,
557th ,,	VIII ,,	,,
1st Aust. ,,	IX ,,	E.
171st Tunnelling Co.	XXII ,,	D.
XXII CORPS.		
63rd Field Co.	9th Div.	E.
64th ,,	,,	,,
90th ,,	,,	,,
97th ,,	21st Div.	,,
98th ,,	,,	,,
126th ,,	,,	,,
105th ,,	25th Div.	N.E.
106th ,,	,,	,,
130th ,,	,,	,,
225th ,,	39th Div.	,,
227th ,,	,,	,, Employed under VIII Corps
234th ,,	,,	,, Employed under VIII Corps
57th ,,	49th Div.	E.
456th ,,	,,	,,
458th ,,	,,	,,
12th ,,	6th Div.	,,
459th ,,	,,	,,
509th ,,	,,	D.
200th ,,	30th Div.	,, Attached 49th Div.
201st ,,	,,	,, Attached 49th Div.
202nd ,,	,,	E.

SIGNALS.

KEMMEL (SECOND BATTLE). 25TH-26TH APRIL, 1918.

Unit.	Formation.	Remarks.
2nd Army Signal Co.		N.E.
"Y" Corps Signal Co.	XXII Corps	D.
9th Divl. Dig. Co.	,,	E.
21st ,,	,,	,,
25th ,,	,,	,,
39th ,,	,,	N.E.
49th ,,	,,	E.
6th ,,	,,	D.
30th ,,	,,	N.E.

BÉTHUNE. 18TH APRIL, 1918.

Unit.	Formation.	Remarks.	
FIRST ARMY.			
ARMY TROOPS.			
"D" Special (Cylinder) Co.	XI Corps	N.E.	
No. 1 Special (Mortar) Co.	XI ,,	,,	
148th Army Troops Co.	I ,,	,,	
230th ,,	XI ,,	,,	
552nd ,,	XI ,,	,,	
560th ,,	I ,,	D.	
170th Tunnelling Co.	I ,,	,,	
250th ,,	XI ,,	N.E.	
251st ,,	I ,,	E.	
No. 10 Foreway Co.	I ,,	N.E.	
I CORPS.			
23rd Field Co.	1st Div.	E.	
26th ,,	,,	,,	
409th ,,	,,	,,	
56th ,,	3rd Div.	,,	
438th ,,	,,	,,	
529th ,,	,,	,,	
9th ,,	4th Div.	,,	
406th ,,	,,	,,	
526th ,,	,,	,,	
XI CORPS.			
476th Field Co.	61st Div.	E.	
478th ,,	,,	,,	
479th ,,	,,	,,	
400th ,,	51st Div.	N.E.	
401st ,,	,,	E.	With 154th Inf. Bde.
404th ,,	,,	N.E.	

SIGNALS.

BÉTHUNE. 18TH APRIL, 1918.

Unit.	Formation.	Remarks.
First Army Signal Co.		N.E.
"A" Corps Signal Co.	I Corps	,,
1st Divl. Signal Co.	,,	E.
3rd ,,	,,	D.
4th ,,	,,	E.
I. Corps Signal Co.	XI Corps	D.
61st Divl. Signal Co.	,,	,,
51st ,,	,,	N.E.

SCHERPENBERG. 29TH APRIL, 1918.

Unit.	Formation.	Remarks.	
SECOND ARMY.			
ARMY TROOPS.			
20th Army Troops Co.	II Corps	D.	
42nd ,,	XXII ,,	E.	
133rd ,,	XXII ,,	D.	
134th ,,		E.	
136th ,,	XXII Corps	N.E.	No diary.
138th ,,	II ,,	,,	
141st ,,		,,	
235th ,,	VIII Corps	,,	
289th ,,	II ,,	,,	
557th ,,	VIII ,,	,,	
1st Aust. ,,	VIII ,,	,,	

SCHERPENBERG. 29TH APRIL, 1918.

Unit.	Formation.		Remarks.
171st Tunnelling Co.		D.	
258th ,,	VIII Corps.	N.E.	
No. 8 Foreway Co.	XXII ,,	E.	No diary. With 42 A.T.Co.
No. 9 ,,	XXII ,,	,,	No diary. With 42 A.T.Co.
No. 351 E. & M. Co.	XXII ,,	N.E.	
XXII CORPS.			
12th Field Co.	6th Div.	E.	
459th ,,	,,	,,	
509th ,,	,,	N.E.	
97th ,,	21st Div.	E.	
98th ,,	,,	,,	
126th ,,	,,	,,	
105th ,,	25th Div.	,,	
106th ,,	,,	N.E.	
130th ,,	,,	E.	
225th ,,	39th Div.	N.E.	
227th ,,	,,	,,	
234th ,,	,,	,,	
57th ,,	49th Div.	E.	
456th ,,	,,	N.E.	
458th ,,	,,	E.	
63rd ,,	9th Div.	E.	Under 49th Div.
64th ,,	,,	N.E.	
90th ,,	,,	,,	
VIII CORPS.			
200th Field Co.	30th Div.	N.E.	
201st ,,	,,	,,	
202nd ,,	,,	E.	
II CORPS.			
228th Field Co.	41st Div.	D.	
233rd ,,	,,	N.E.	
237th ,,	,,	D.	

SIGNALS.
SCHERPENBERG. 29TH APRIL, 1918.

Unit.	Formation.		Remarks.
2nd Army Signal Co.		N.E.	
"Y" Corps Signal Co.	XXII Corps	,,	
6th Divl. Signal Co.	,,	E.	
21st ,,	,,	,,	
25th ,,	,,	,,	
39th ,,	,,	N.E.	
49th ,,	,,	E.	
30th ,,	,,	N.E.	
9th ,,	,,	,,	

AISNE, 27TH MAY-6TH JUNE, 1918.

Unit.	Formation.		Remarks.
IX CORPS.			
245th Army Troops Co.	IX Corps	E.	
2nd Field Co.	8th Div.	,,	
15th ,,	,,	,,	
490th ,,	,,	,,	
81st ,,	19th Div.	,,	
82nd ,,	,,	,,	
94th ,,	,,	,,	
97th ,,	21st Div.	,,	
98th ,,	,,	,,	
126th ,,	,,	,,	

AISNE. 27TH MAY-6TH JUNE, 1918.

Unit.	Formation.		Remarks.
105th Field Co.	25th Div.	,,	
106th ,,	,,	,,	
130th ,,	,,	,,	
7th ,,	50th Div.	,,	
446th ,,	,,	,,	
447th ,,	,,	,,	

SIGNALS.
AISNE, 27TH MAY-6TH JUNE, 1918.

Unit.	Formation.		Remarks.
E. Corps Signal Co.	IX Corps	E.	
8th Dvl. Signal Co.	,,	,,	
19th ,,	,,	,,	
21st ,,	,,	,,	
25th ,,	,,	,,	
50th ,,	,,	,,	

N.B.—"MARNE, 1918" COUNTS AS AN EXTRA HONOUR FOR PARTICIPATION IN THE BATTLE OF SOISSONNAIS-OURCQ AND TARDENOIS.

SOISSONNAIS-OURCQ, 23RD JULY-2ND AUGUST, 1918.

Unit.	Formation.		Remarks.
73rd Field Co.	15th Div.	E.	Under XX French Corps.
74th ,,	,,	,,	
91st ,,	,,	,,	
207th ,,	34th Div.	,,	Under XXX French Corps.
208th ,,	,,	,,	
209th ,,	,,	,,	

SIGNALS.
SOISSONNAIS-OURCQ, 23RD JULY-2ND AUGUST, 1918.

Unit.	Formation.		Remarks.
15th Divl. Signal Co.	15th Div.	E.	Under XX French Corps.
34th ,,	34th Div.	,,	Under XXX French Corps.

TARDENOIS, 20TH-31ST JULY, 1918.

Unit.	Formation.		Remarks.
XXII Corps (under 5th French Army).			
400th Field Co.	51st Div.	E.	
401st ,,	,,	,,	
404th ,,	,,	N.E.	Bridging just south of area.
457th ,,	62nd Div.	E.	
460th ,,	,,	,,	
461st ,,	,,	,,	

SIGNALS.
TARDENOIS, 20TH-31ST JULY, 1918.

Unit.	Formation.		Remarks.
"Y" Corps Signal Co.	XXII Corps	D.	
51st Divl. Signal Co.	51st Div.	E.	
62nd ,,	62nd Div.	,,	

AN UNOFFICIAL HISTORY OF THE SIGNAL SERVICE WITH THE BRITISH SALONIKA FORCE, 1915-18.

(*Concluded.*)

By CAPTAIN C. C. S. WHITE, M.B.E., R.E.

JULY TO SEPTEMBER, 1918.

FINAL ATTACK, SEPTEMBER, 1918.

During the month of June, 1918, the Greek Army was steadily being brought into the line, and two Divisions were already holding a portion of the Struma front under the British. The 27th Division moved from the Struma to the west bank of the Vardar, and took over from the 122nd French Division. Their Divisional Headquarters at Drevino was in direct communication with G.H.Q. in Salonika, as well as with the XII Corps at Janes, by good permanent lines constructed earlier in the year. This Division opened the final offensive by capturing some two miles of the Bulgar positions to a depth of 1,000 yards on the hills west of the Vardar, and so dominated Gevgheli.

It soon became clear that a grand offensive was imminent. Preparations were made for strengthening advanced lines. The XVI Corps moved from the Struma to Snevce in August. The health of the Signals Service personnel was extremely good considering the time of the year. Units as a whole were only 100 below establishment at the end of August.

On September 12th the I Greek Corps of three Divisions, which was now directly under the orders of British G.H.Q., was holding the Struma front. The XVI Corps Headquarters was near Snevce, with a Report Centre at Sal Grec de Popovo. This Corps was now composed of the 28th Division and the Greek Cretan Division.

General Milne's advanced H.Q. was near Ismali. The XII Corps Report Centre was on Piton Rocheux, opposite the "Pip" ridge and "Grand Couronne." This Corps was now composed of the 22nd and 26th Divisions and the Greek Seres Division. The 27th Division was on the west bank of the Vardar overlooking Gevgheli, as already mentioned.

The line was prolonged to the west by more Greeks, the Serbs on the Cerna River, the French near Monastir, and the Italians in Albania.

Opposing us there were at that time the Eleventh German Army in Albania (composed chiefly of General Pflanzer-Baltin's Austrian Corps, a large number of Bulgarian troops and a smattering of Germans).

In the centre, from a point almost due north of Monastir to the Vardar River, was the First Bulgarian Army. To the east the Second Bulgarian Army held from the Vardar River to the Gulf of Orfano. All the Turkish troops had been withdrawn from the front in the summer of 1917.

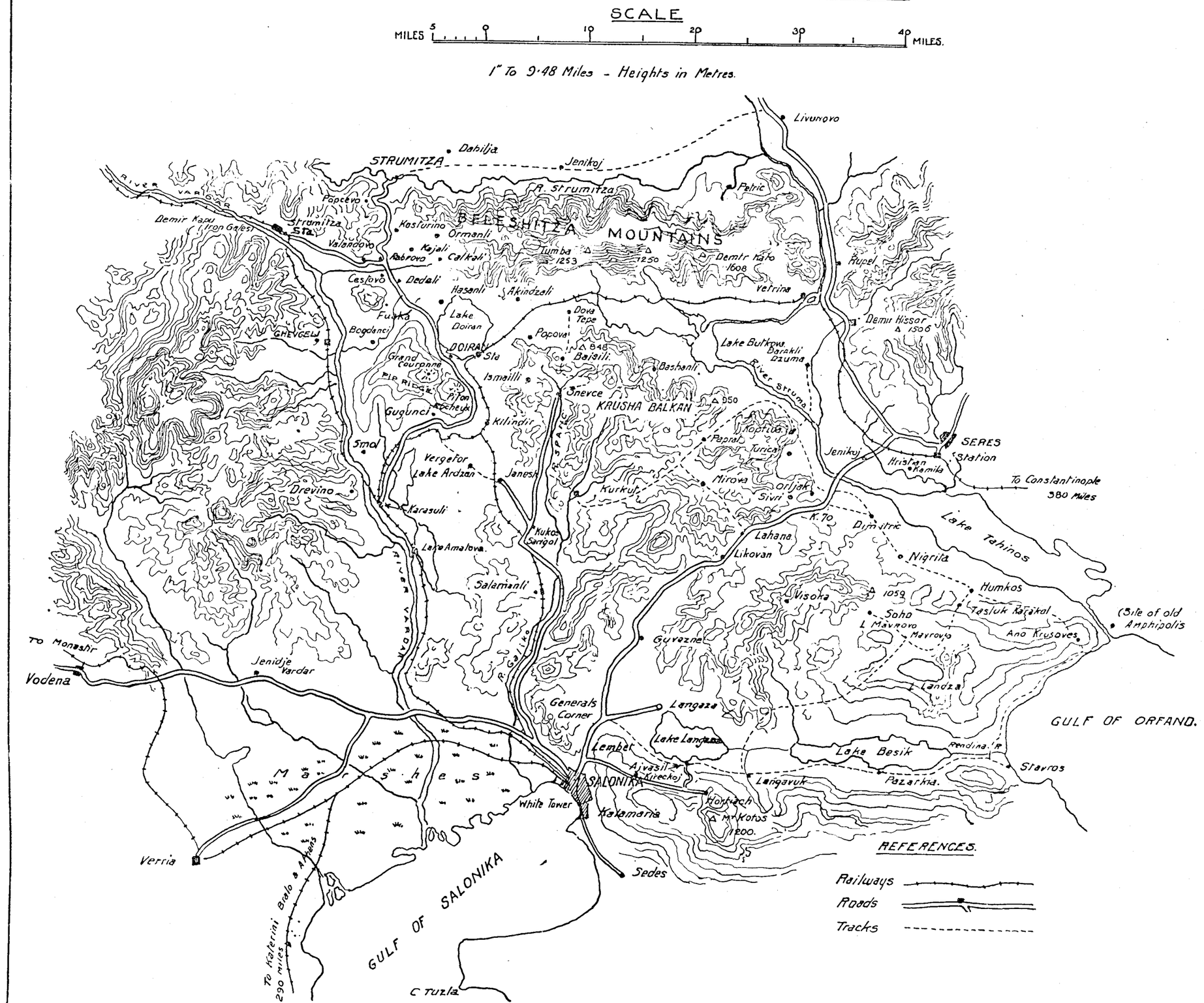
The general plan of our attack was founded on the experience of previous Balkan campaigns, more particularly the Greek campaign of 1913 against Bulgaria, and was simplicity itself. The main attack was to come in the centre opposite the Dobropolje, on a comparatively small front of 15 miles. If a complete break-through were effected, the attack was to be extended on either flank from the north-west of Monastir to the Vardar, involving all the central position of our line on a 70-mile front. Everything depended on the rapid advance of the spear head of the attack, which position of honour was entrusted to the Serbian Army. Concurrently with the attack in the centre, an attack had been planned on the right, to be undertaken by the Anglo-Greek forces on both sides of Lake Doiran, with the object of immobilizing the Second Bulgarian Army, and preventing them detaching troops to the assistance of the First Army in the centre.

The attack by the Serbs and the French on the Cerna front commenced at dawn on Sunday, September 15th, when the Bulgar positions were successfully stormed with comparatively slight losses, and the advance into the Bulgar position was energetically pushed forward. The attack by the British and the Greeks on the Doiran position was launched at 5 a.m. on Wednesday, September 18th. The attack on the "Pip" ridge was unsuccessful. The Seres Greek Division captured Doiran town, Teton Hill and the Petit Couronne. The Greek Cretan Division attacked between Doiran Lake and the Belashitza Range, but the Bulgar position was not penetrated. The casualties on both sides were extremely heavy.

No information was obtained for several hours from the British troops attacking the "Pip" Ridge, as all the advanced cable lines were cut by artillery fire, and the pigeons which were to have been taken had been left behind.

The Seres Division, however, took 36 carrier pigeons from a semi-mobile loft, which had been erected a fortnight previously at Piton Rocheaux, the advanced XII Corps Headquarters. These birds came back well from 7 a.m. onwards, and 12 of them brought back useful information by noon. The wording of these messages could not always be taken too literally; one of them ran "We have 200 prisoners— send us some more bombs."

SKETCH MAP OF THEATRE OF OPERATIONS.



The Serbian advance on Prilep and Krivolak was reported to be progressing very satisfactorily.

On Thursday, September 19th, the attack was resumed at 5.20 a.m., with fresh British troops, while the Seres Division attacked and advanced well up the slopes of the Grand Couronne; but owing to our failure to secure "Pip" Ridge on the left, this position became untenable, and on the afternoon of the 19th the engagement was broken off, so we consolidated our gains of the previous day. Although we had only slightly advanced, we had succeeded in pinning down the Bulgar to his position. Not a man nor a gun was detached to assist the First Bulgarian Army.

Meanwhile the Serbs were still continuing their advance, and on September 20th, they were approaching the Vardar, north of Mirovene.

Pursuit into Bulgaria.

At mid-day on September 21st, came the cheering news that the Serbs had cut the enemy lines of communication up the valley of the Vardar, at Demir-Kapu—the Iron Gates—the exact spot where the Greeks cut it in 1913. As a result of this only an immediate retreat from the Doiran position could save the Bulgar from utter disaster; furthermore his only line of retreat was along the road which runs north of Doiran Lake, through Hasanli Dedeli and Robrovo, up the steep pass of Kosturino on to the broad plateau which forms part of the extreme west of the Belashitza mountains, then down again on to the Strumitza Plain. This road was in good repair as far as Robrovo, but the section from there to Strumitza was never intended for use as a main communication; it was tortuous and steep and very lightly metalled.

The Bulgars evacuated their main position on the night of the 21st/22nd September. The pursuit was taken up forthwith by the British cavalry. All units were on the move early on the 22nd. The two Corps changed over. This was inevitable, as the two Divisions now forming the XII Corps—the 22nd and the 28th—had been reduced to skeleton formations, the former by the attack, the latter through sickness. The XVI Corps was now composed of the Cavalry, the 26th Division, the 27th Division from the west bank of the Vardar, and the 14th Greek Division hastily summoned from the south. General Briggs, the Corps Commander, was relentless in his pursuit. The cavalry kept touch with the enemy throughout; they were closely supported by the 26th Division.

On the third day, September 24th, the Bulgars were driven up the Kosturino Pass, being ruthlessly bombed and machine gunned all the way by the R.A.F., who wrought devastating havoc amongst them, and turned their retreat into a hopeless rout.

The Derbyshire Yeomanry entered Bulgaria at Kosturino on the 25th, whilst units of the 22nd and 28th Divisions, assisted by Greek

troops, attained the summit of the Belashitza. The XVI Corps advanced Report Centre* (QRC) was established at Furka, and was in communication with 16th Corps Headquarters (QCO) and G.H.Q., by a composite line of cable, standard airline and permanent line (both enemy and our own), through Bogdanci, Stojakovo, Smol and Vergetor, this being the road, or rather track, along which the Corps had advanced. As the track was very indefinite through "No Man's Land," great care was taken to place the airline as far out of reach as possible, and so this line lasted, as the sole means of communication with our advanced Corps, until the Army Signal Company replaced it, on September 28th, by a four-wire permanent route along the main road through Doiran Town to the Dedeli Pass.

On Thursday, September 26th, our advanced troops captured Strumitza. QRC moved to Popecvo, having advanced 35 miles in 4 days. QCO moved to Furka; throughout the advance they were only one day's march behind QRC, General Brigg's Report Centre.

The XII Corps established their Report Centre, MRC at Border Hill.

The 28th Division and the Greeks were working their way eastward along the Belashitza Ridge.

The Army Signals, Nos. 1 and 60 Airline Sections and A.H. Cable Section, were hard at work building an eight-wire route through the old "No Man's Land," to bridge the gap of some ten miles between the British system and the German-Bulgar system of permanent lines, and so complete four pairs of wires for the proposed move of Army Headquarters to Cestovo. No 39 Motor Airline Section was sent up by the L. of C. Signal Company to assist.

About a month before the attack, one of the Airline Sections (No. 38), attached to the XVI Corps Signals, was converted from Horse to Motor Transport. This proved a great asset in the advance, as this section was able to push ahead with its lorries, and prepare ten to fifteen miles of wires during the day, and so keep the Corps

*NOTE.—Signal Offices take their call signs from the Headquarters that they represent. Battalions use their Regimental abbreviations suffixed by a letter of the alphabet to indicate the number of their battalion, thus:

HAMJ	10th Battn, of the Hampshire Regiment.
RIRF	6th Battn, Royal Irish Rifles.

Divisions and Brigades use the letters Y and Z respectively prefixed by a letter denoting their number; their report centres add the letter R, thus:

YJ	10th Division.
YBGR	27th Division Report Centre.
ZBI	29th Brigade.

Corps and Army Headquarters are denoted by the letters CO and AR, whilst their report centres change these into RC and CP respectively, thus:

MCO	XII Corps Headquarters.
QRC	XVI Corps Report Centre.
SAR	Salonika Army Headquarters.
SCP	Salonika Army Command Post.

Commander at QRC in telephonic and telegraphic communication with the remainder of his staff at QCO each night. The policy adopted by the Chief Signal Officer, XVI Corps, was to join through the two *top* wires on the Bulgarian routes, labelling them carefully at all junctions, and making good gaps with airline. The top wires are usually the best wires on a route, and can be safely assumed to be the "through" trunk lines from town to town; in this particular case they were 200-lb. copper wire, in excellent condition, except where they had been intentionally demolished. A definite decision such as this saves considerable confusion to those who come after. When this was not done, the Army Signals experienced unnecessary trouble, caused by linemen, who had a tendency to take a narrow partisan view of inter-communication problems, chopping the lines about with regard only to their immediate requirements.

The following instances give some idea of the wear imposed by the rough roads on the M.T. vehicles, and the remarkable way in which they withstood it. On one occasion the engine of a Ford van fell out—one of the rear supporting lugs fractured—when the car was 40 miles from camp, so it was lashed to the chassis with eight strands of 200-lb. G.I. wire. This not only carried the car home, but also a further 120 miles back to the Base M.T. Depot. On another occasion one of the Dennis lorries, of No. 38 Airline, was sent down from Sveti Vrac to Salonika, over a hundred and fifty miles of rough and hilly roads. When it arrived, the tyre was removed from one of the back wheels, whereupon the wheel fell into 37 pieces. The O.C. of the Base M.T. Depot sent for the two drivers of the lorry and congratulated them.

During the next four days, fighting took place on the hills to the north of Strumitza, and to the east along the valley, in the direction of Petric, where the upper Struma and the Strumitza valleys join. Considerable resistance was met with near Yenikoj (about half-way between Strumitza and Petric). The XVI Corps moved into Strumitza on the 27th, and on to Dabilja on the 28th. In the meantime Bulgar delegates had passed through our lines to sue for peace. The armistice was signed on the 29th, and came into effect at mid-day on September 30th, 1918.

On the morning of the 30th, the 26th Division was only 15 miles away from the only line of communication (which runs through the Rupel Pass and up to the Struma valley), open to the Bulgarian Corps operating in the lower Struma. Had it not been for the armistice it is probable that the whole of their force would have had to lay down its arms.

So ended an advance of some 60 miles in 8 days, undertaken by an Army that had been fighting for three years in an extremely difficult country.

OCCUPATION OF BULGARIA.

However, this was by no means the end for the British Salonika Force, and for Signals in particular. The XVI Corps Signals were fortunate in being able to use the Bulgar permanent lines, which were in excellent condition, and ran along their old, and our new lines of communications. Immediately after the armistice, No. 38 Airline Section went through the Bulgar line to repair the two top wires where they had been cut by shell-fire, ready for the next move of advanced Corps Headquarters to a point 14 kilometres west of Petric. When they returned to camp at Dabilja that night they discovered they had joined QRC direct through to 2nd Bulgarian Army Headquarters at Sveti Vrac.

By the conditions of the military convention with Bulgaria, the Allies were to be given every facility for the transport of our troops in their country. The British Army was originally to occupy Sofia, and the whole of Bulgaria as far as Widin on the Danube. With this intention in view QRC moved from Dabilja, on October 5th, down the Strumitza valley, and across the Struma to Sveti Vrac, a little village on the edge of a forest, where the Bulgar Second Army had established their headquarters. They had built most palatial residences, which were cleverly concealed by the trees. There were at least two hundred bedrooms, offices, and officers' messes, all fitted with electric light and an ample water supply; as well as three or four suites, completely furnished, for the Army Commander and the Chiefs-of-Staff. In addition to all this, there were the Turkish Baths! The Bulgars had made use of a natural hot spring of sulphuric water, which came out of the ground at 200°F This they diverted into the bath house, which comprised a series of small swimming baths, each hotter than the other.

The ultimate policy of G.H.Q. was not to use the Strumitza L. of C., which consisted of a very lightly metalled road from Doiran to Yenikoj, that would break up entirely as soon as the rain came, but to press on with the reconstruction of the railway from Doiran to Vetrina Bridge, at the southern entrance of the Rupel Pass, and to use the Bulgar Decauville railway from there to Radomir and Sofia. So Army Signals started to build an eight-wire permanent route alongside the railway to Vetrina Bridge, where they established a Signal Office. Progress, however, was slow, owing to transport difficulties and the necessity of clearing the route of trees and scrub. Furthermore, as Sections were required for construction of other lines, on account of the move eastwards against Turkey, it was decided to reduce the number of wires to four and arm the railway poles, thus saving the erection of a new line of poles through very wooded country.

Move East against Turkey.

On October 11th it was decided that the British and the Greek Armies, under the supreme command of General Milne, were to move east against Turkey.

The XII Corps (22nd and 28th Divisions), moved to Stavros, whence they were to embark for Dedeagatch, and gradually take up positions along the River Maritsa, which formed the Turko-Bulgarian frontier from Adrianople to the sea, whilst the Greeks marched to this same line through their lost province of Eastern Macedonia, which the Bulgars immediately evacuated under the terms of the armistice.

The XVI Corps (26th and 27th Divisions) marched up the Struma Valley along the main Sofia road, to a point just south of the Kresna Pass, where the infantry entrained on the Decauville railway, built during the war by the Bulgar, for Radomir, a town twenty-five miles south of Sofia, through which the main Berlin-Constantinople railway runs. At Radomir they re-entrained on the broad gauge, and went through Sofia to Mustapha Pasha (or Svilengrad), the frontier town opposite Adrianople, on the Maritsa. The gunners and all horse transport entrained at Kostenets; mechanical transport went by road all the way through Dubnitza, Samakov, Kostenets, Phillipopolis and to Mustapha Pasha—a distance of 260 miles.

Lieut.-Colonel C. H. Prickett, D.S.O., R.E. (Chief Signal Officer XVI Corps), was placed in charge of all Signal communications east of Strumitza and north of Vetrina Bridge, on October 12th. He was responsible for maintaining communications from Strumitza and Vetrina up to XVI Corps Headquarters (QCO), from there to QRC., and to the 26th and 27th Divisions during their march up the Struma Valley and on to the Bulgarian frontier at Mustapha Pasha. He proceeded to Sofia and interviewed M. Nedlekoff, the Bulgarian Minister of Posts and Telegraphs, who issued instructions to all telegraph offices along our route to give every assistance to all British Signals, which they most certainly did.

Colonel Prickett opened a Signal office and telephone exchange in the British Legation at Sofia. The Bulgars lead in their main telephone line to Sv Vrac, and also the eastern side of the German Berlin-Constantinople telephone line. Double-current Duplex Telegraph was superimposed on both these telephone circuits. Telephone speech from Sofia to Sv Vrac and Salonika was excellent.

QRC moved via Kostenets, and arrived at Svilengrad on September 20th. The Headquarters of the XVI Corps Signal Coy. moved there by train, and No. 38 Motor Airline Section went by road from Sv Vrac, 240 miles in 5 days.

The German telephone line from Berlin to Constantinople was built of the very finest material during the war, evidently for

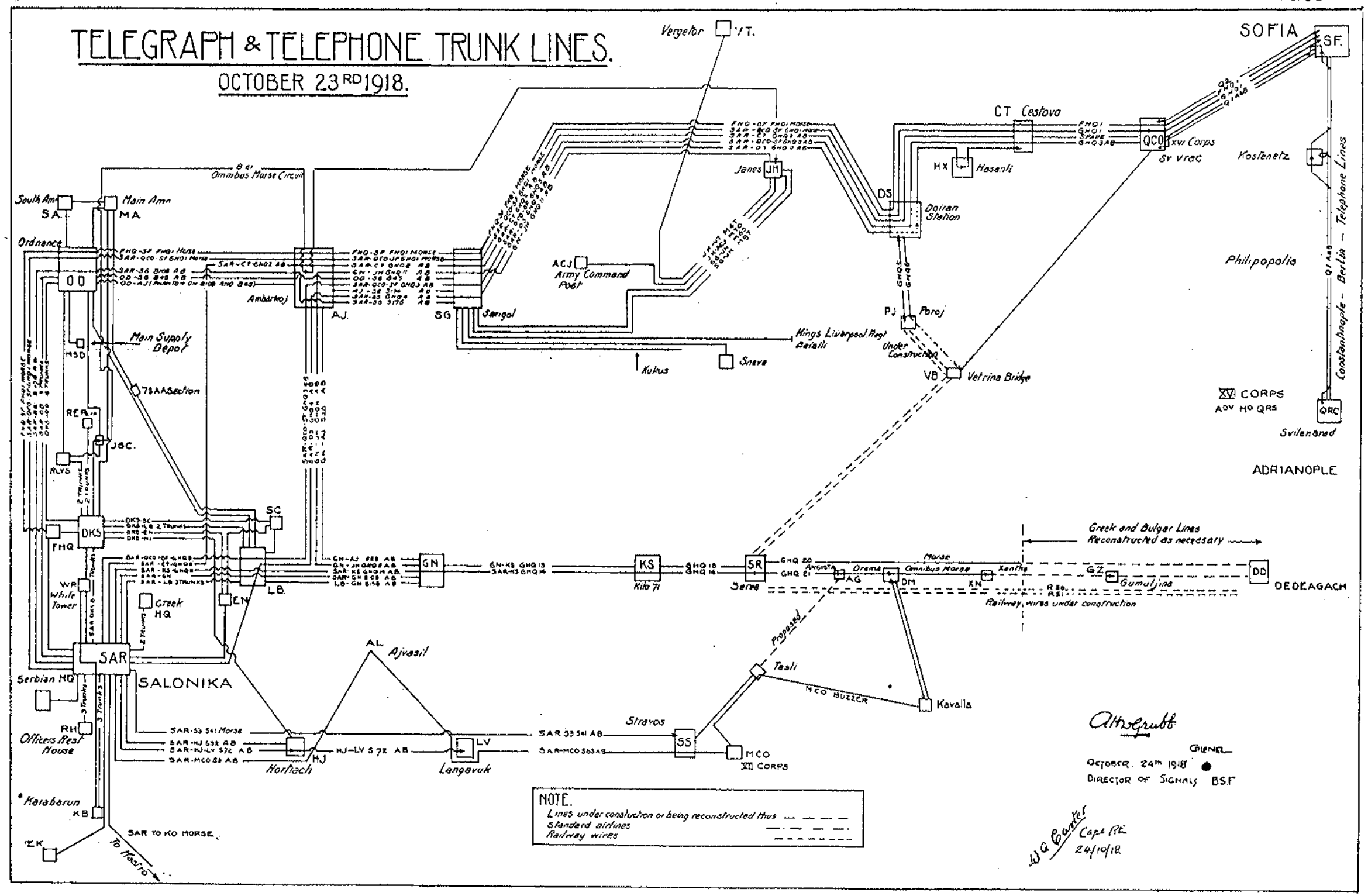
propaganda as well as for military purposes. It consisted of two 400-lb. copper wires on very large porcelain insulators. From Sofia it ran on the Bulgarian State telephone route alongside the railway as far as Papasli, where it branched off and followed the road to Adrianople on 14 metre poles of its own; the two wires were run as an inside pair on an 8-way arm, and had test points conveniently arranged about every two miles. We used it for a magneto ringing telephone circuit with telegraph superimposed from Svilengrad to Sofia, and a telephone intermediate at Kostenets, a distance of some 200 odd miles, and the telephone speech was absolutely perfect throughout.

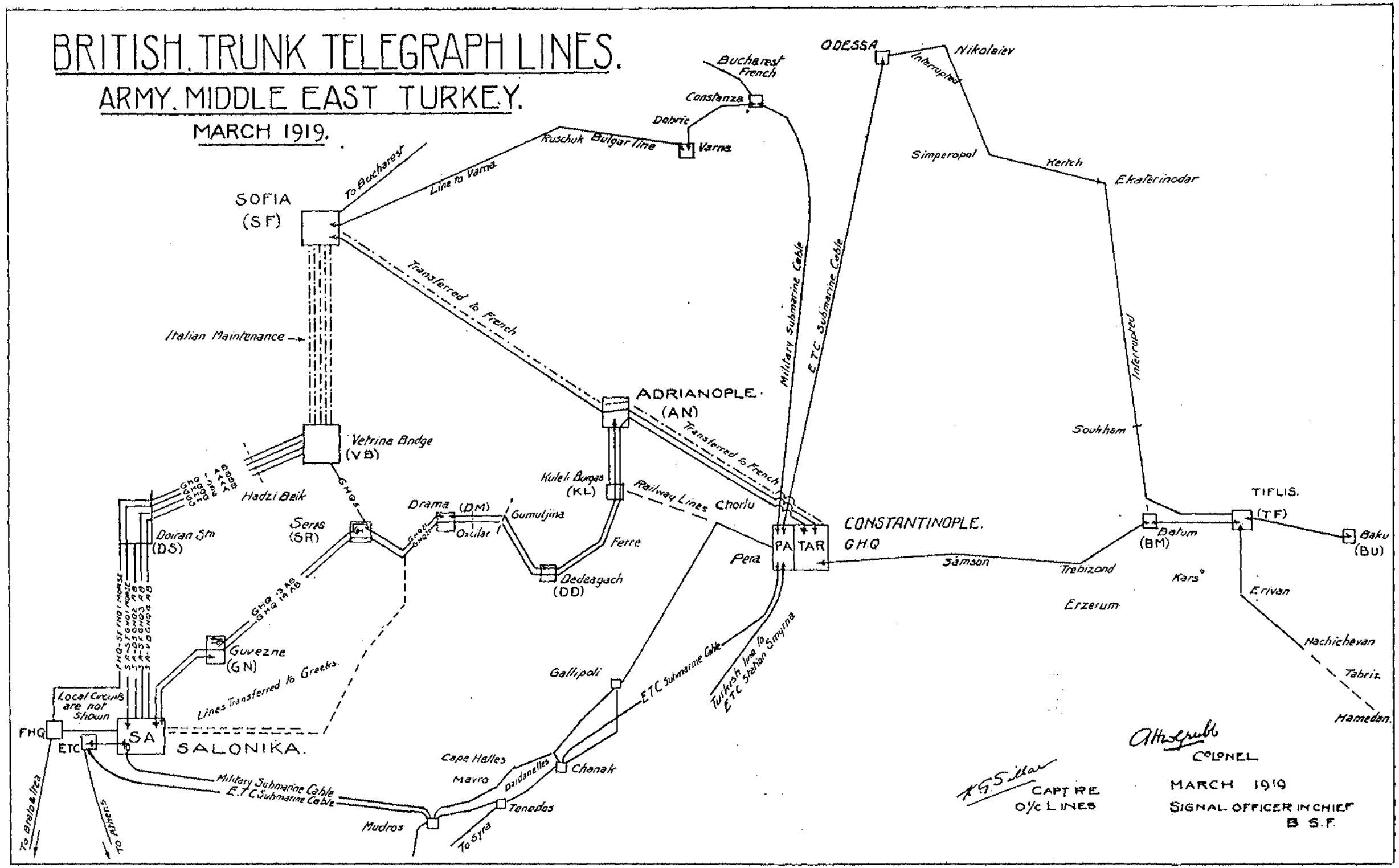
On October 25th, the whole of the 26th Division had reached Svilengrad, and all arrangements had been made for an immediate attack on Adrianople. This, unfortunately, never matured, as the Turks capitulated on October 30th, 1918.

Meanwhile, Colonel A. H. W. Grubb, C.M.G., D.S.O. (Signal Officer in Chief), was concerned with the difficult problem of communications to Dedeagatch, in readiness for the arrival of the XII Corps. There was a good British line as far as Kilo. 69 on the Seres Road; an indifferent line to Kilo. 71; and thence nothing over "No Man's Land" and the Struma plain for 20 kilometres, to Seres. From Seres there had been, in the old days, the Turkish Constantinople-Drama-Seres-Salonika telegraph route. This was, however, largely destroyed, and it was found that most of the wires were being taken into use by the Greeks. The telegraph line along the railway was found standing from Nihor (5 miles S.E. of Seres) to Angista, which had been the Bulgar railhead, and there appeared to be several wires available along the railway to the east.

Time was of paramount importance, so it was decided to use the Seres Road route as far as Kilo. 71, and to build a new permanent route of two pairs of Z9 wire from there to Seres, which was to be our railhead, and from there to repair and use two wires along the railway route. From Seres, one through telegraph wire would be provided for Dedeagatch, and a separate wire for intermediate places, Drama, Xanthi, Gumuldzina, etc.

Two motor airline sections were immediately put on to the construction of the line from Kilo. 71 along the Seres Road as far as the railway crossing, and thence along the railway to Seres station. No. 4 Airline Section was brought down from XVI Corps, and the Airline Sections from XII Corps were also employed. Standard airline and cable were laid from Kilo. 80, via Seres town to Topoljani, and communication established to that place by 22.15 hours on 16th October. The repairs to the line as far as Drama were completed by October 18th, and a Morse set was installed there working to Salonika—thus establishing a telegraph line of 160 kilometres in 6 days.


TELEGRAPH & TELEPHONE TRUNK LINES.
OCTOBER 23RD 1918.
SOFIA
SF.
Vergelor
JT.
CT Cestova
QCO
XVI Corps
Sr Vrac
Kostenetz
Constantinople - Berlin - Telephone Lines
Philipopolis
XVI CORPS
ADV HQ QRS
QRC
Svilenograd
ADRIANOPLE
Janes
JH
HX
Hasanli
DS
Doiran Station
ACJ
Army Command Post
Ambarkoj
AJ.
SG
Sarigol
Kukus
Sneva
Hings Liverpool Regt Balalli
PJ
Poroj
Under Construction
VB
Veltrina Bridge
Omnibus Morse Circuit
South Am
SA.
Main Amn
MA.
Ordnance
OD
Main Supply Depot
MSD
79 AA Section
RE
JSC.
RWS
DKS
FHQ
WR
White Tower
Greek HQ
SC
LB.
EN
SAR
SALONIKA
Serbian HQ
RH
Offices Rest House
Karaburun
KB
EK
SAR TO KO MORSE
To Pastro
AL
Ajvasil
Horliach
HJ
LV
Langevuk
Stravos
SS
MCO
XII CORPS
Tasli
MCO BUZZER
Kavalla
Proposed
GN
KS
Kilo 71
SR
Serres
Greek and Bulgar Lines Reconstructed as necessary
Drama
AG
DM
Omnibus Morse
Xanthe
XN
GZ
Gumuljina
DD
DEDEAGACH
Railway wires under construction
NOTE.
Lines under construction or being reconstructed thus
Standard airlines
Railway wires
Alth Grubb
Colonel
October 24th 1918
Director of Signals BSF
W A Carter Capt RE 24/10/18


BRITISH. TRUNK TELEGRAPH LINES.
ARMY. MIDDLE EAST TURKEY.
MARCH 1919.
SOFIA (SF)
To Bucharest
Line to Varna
Ruschuk Bulgar Line
Varna
Dobric
Constanza
Bucharest French
Transferred to French
Italian Maintenance
Vetrina Bridge (VB)
Hadzi Beik
Doiran Stn (DS)
Seras (SR)
Drama (DM)
Oscilar
Gumuljina
Kuleli Burgas (KL)
Dedeagach (DD)
Ferre
ADRIANOPLE. (AN)
Transferred to French
Railway Lines
Chorlu
Guvezne (GN)
Lines Transferred to Greeks.
Local Circuits are not Shown
FHQ
ETC
SA
SALONIKA.
To Belgrade
To Athens
Military Submarine Cable
E.T.C. Submarine Cable
Mudros
Cape Helles
Mavro
Dardanelles
Chanak
Tenedos
To Syra
Gallipoli
E.T.C. Submarine Cable
Turkish line to E.T.C. Station Smyrna
Pera
PA
TAR
CONSTANTINOPLE.
G.H.Q
Samson
Trebizond
Erzerum
Kars
Erivan
Nachichevan
Tabriz
Hamedan
Baku (BU)
TIFLIS. (TF)
Batum (BM)
Sukhum
Kertch
Ekaterinodar
Simferopol
Nikolaiev
ODESSA
Military Submarine Cable
E.T.C. Submarine Cable
Interrupted
Interrupted
Colonel
CAPT R.E.
O/C LINES
MARCH 1919
SIGNAL OFFICER IN CHIEF
B.S.F.

On October 22nd, No. 3 Airline Section reached Xanthi, and established a Morse and telephone Signal Office there. Two wires on the railway route were demanded from the Bulgars for communication to Dedeagatch. Certain changes were necessary in the Bulgar railway communications to place the desired wires at the disposal of the British, and the Bulgars were somewhat reluctant to do this. So the Signal Officer in Chief proceeded to Xanthi to deal with the matter in person, and when he made it clear that the British Signals were in a position to take complete control, the Bulgars acquiesced, and one top railway wire was handed over, the second to follow in a few days when the British were ready for it. On October 28th, the advanced detachment of No. 1 Airline Section reached Dedeagatch and opened a Signal Office at 19.00 hours with Morse communication to Gumuldzina, and thence to Drama, and Salonika. The advanced party of XII Corps Signals, with a wagon wireless station, landed that afternoon. Although this line was "through" there was still a great deal of work to be done, cutting out temporary repairs and clearing the line of trees and "earths" generally. Large parties were employed on this work until its completion. A diagram of telegraph and telephone routes on this date is given on Plate IV.

Occupation of Constantinople.

The Armistice with Turkey, which was signed on October 30th, on board H.M.S. "Agamemnon," at Mudros, put an end to any military operations on the river Maritsa. Nevertheless it meant a long programme of work for Signals, as a division (the 28th) was to be sent to the Dardanelles. The XII Corps Staff were to go to Constantinople, the 26th Division was to join the Army of the Danube. The 22nd and 27th Divisions were stopped and brought back to Stavros and Salonika.

The XII Corps Signals opened an office at Dimotika on November 4th, and steps were taken to push on telegraph lines to Adrianople, for communication to Constantinople.

Commander W. H. Cottrell, R.N.V.R., established communication to Constantinople on November 8th, via Eastern Telegraph Company's cables and Turkish land lines through Smyrna.

On November 9th, General Sir H. F. M. Wilson, with a portion of his Staff and XII Corps Signal Company, embarked at Dedeagatch for Constantinople. The XVI Corps Headquarters started to move from Svilengrad to Janesh; the 26th Division to Ruschuk.

The news of the signing of the armistice with Germany was received by wireless at 09.30 hours (07.30 hours Paris time), and was immediately circulated to all signal offices, where it was displayed in large letters over the usual wireless news, which was habitually posted daily outside signal offices on special notice boards.

XII Corps Headquarters arrived at Constantinople on November 12th, and were in communication with Salonika, via Smyrna, as already mentioned. Official messages took from three to ten hours in transmission.

Army Signals opened a signal office at Adrianople on November 17th, and established direct telegraph communication from Sofia to Constantinople at 21.15 hours. The next day direct telegraph communication was established between Salonika and Constantinople at 17.00 hours. There were at first six offices on this line, which was 450 miles long. Although there were no translating relays in circuit, the signals were quite good.

Lieut.-Colonel H. C. Saunders, D.S.O., R.E., and the party of XII Corps Signals that landed in Constantinople on November 12th, immediately opened a signal office (CN) in the Grand Rue de Pera, took over the wireless stations at Osmanie and Ok Meidan, and closed the German Signal Office in Constantinople. The XII Corps Signal Company was re-named the Allied Force Headquarters Signal Company. During the remainder of the month they did an immense amount of work, mostly on local lines and the direct lines which were put through to Salonika on November 18th.

As regards telephones in Constantinople, we were in an ideal position, because the *Société Ottomane Téléphonique*, whose staff was composed largely of old National Telephone Company engineers, had installed a very complete system of paper insulated underground cables radiating from their exchanges at Pera, Stamboul, and in the suburbs. These lines were all in good condition as they were working Central Battery system telephones. They terminated in junction boxes, containing from 5 to 30 pairs, conveniently situated on the walls of houses about 15 feet from the ground. From these boxes twisted V.I.R. cables were run to the various telephones in the vicinity. In the centre of the city there was a box every 50 to 100 yards, and there were plenty of spare pairs in each box. All the lines and boxes were clearly numbered, and recorded at Pera Exchange. M. Papasien, the Chief Engineer at Pera, an Armenian who remained loyal to the Company during the German occupation of Constantinople, had kept everything in as good order as he possibly could, and on our arrival was of the greatest assistance to us. We installed a 100-line Magneto Switchboard, with a British operator, in his Test Room at Pera, and then ran a pair of D5 cables to the nearest junction box, whilst he made the necessary connections on the jumper frame.

On November 16th, Signals Sofia established communication from his office over Bulgar lines to the 26th Division at Ruschuk.

An advance party of G.H.Q. Signals opened the G.H.Q. Signal Office (TAR) in the Turkish Military School at Constantinople,

on December 7th. They also opened a Signal Office (PA) in the old German Signal Office, which was in the same building as the Eastern Telegraph Company's office, and so very convenient for working on their cables and the Turkish telegraph lines. They gradually took over the work started by XII Corps Signals. All the lines in the Salonika area were handed over to the L. of C. Signal Company, and by the end of the month the whole of the G.H.Q. Signal Company had moved to Constantinople.

The Eastern Telegraph Company's cable from Syria, via Tenedos and Chanak, was put through to Constantinople at 21.00 hours on December 17th. This gave us direct communication with the 28th Division in the Dardanelles, as well as alternative line to Salonika.

The E.T.C's cable to Odessa was put through by December 29th. Communication was established from there to Ekaterinodar, via Rostov, but this was soon interrupted by the Bolsheviks.

The German cable to Constanza was restored in January.

When the 26th Division moved to Varna, the line from Sofia to Ruschuk was extended by another Bulgar line to Varna. This was perfectly satisfactory, and messages were sent to them via Sofia. Generally speaking, it was found that Russian telegraph lines (in the Caucasus) and lines in Bulgaria worked considerably better than any lines we took over in Turkey.

By February 1st it was possible to work Wheatstone on the Salonika-Constantinople direct line, which was then carrying something like 20,000 words per day. The reason for this colossal amount of traffic was that the post took three days each way.

A route diagram of these and other lines is appended Plate V.

The Caucasus and South Russia.

In the middle of December, 1918, Captain P. A. Hitchcock, M.C., R.E., and 16 other ranks from the Allied Force Headquarters Signal Company, Constantinople, embarked for Batoum, they formed the nucleus of what eventually developed into the Caucasus Signal Company. There was an existing land line to Batoum from Constantinople, via Kastamuni, Sinope, Samsun and Trebizond. Arrangements were made with the Turkish authorities to join this line through to the British signal offices at Pera and Batoum for certain periods each day. There were two translating relays, at Samsun and Trebizond respectively, which were adjusted by Turkish operators. The line was 700 miles long, and in a somewhat precarious condition. It was, however, possible to work single current Morse at a rate of eight to twelve words per minute; above this speed the signals were distorted by the capacity of the line.

By the end of the year the 27th Division had reached Batoum, where they left one Brigade. Divisional Headquarters and the other two Brigades proceeded to Tiflis, and from there on into Armenia. Their role was to stop the war which was being waged between Georgia and Armenia. Unfortunately, time and space do not permit any further account of the interesting experiences of Signals in the Caucasus. Let it suffice to mention that communication was established to Baku, which was occupied by the 39th Brigade, which had reached there from Persia, and across the Caspian Sea to Kradnovodsk, down along the railway to Kars, Erivan, Tabriz, and eventually, for a short time, by the Indo-European Telegraph line to Karachi and Bombay.

The Army Wireless Company, who had taken over the German high-powered Wireless Station at Osmanie, just outside Constantinople, established a station at Novrossisk, and so maintained communication with the Mission sent to the assistance of General Deniken in South Russia. At Tiflis the existing Russian station was reorganised and opened up for communication with Constantinople, Batoum, Baku and Basra, while a set was installed at Batoum, as an alternative to the land line to Constantinople, and as an additional means of communication with the Russian Mission, in case of failure of the cable via Odessa.

Osmanie proved useful both to the Navy and Army by transmitting a large amount of traffic to Malta and thus relieving congestion on the cables.

It will have been noticed how the work of the Signal service changed rapidly after the capitulation of Bulgaria in September, 1918. Field lines, buzzer and visual signalling dropped out almost entirely, and gave place to telegraph and telephone working over long distant permanent lines. It was only by the experience of this type of work gained by officers and men whilst in Salonika, and the previous experience of several of all ranks who had been in the Postal Telegraph Service at home, that it was possible to put in order, maintain and operate these long trunk communications

So ends the history of the Signals of the British Salonika Force, which started with no lines at all, and finished up with lines from Athens to Tabriz.

M. G. O. E.

TECHNICAL EXAMINATION BRANCH FOR R.E. SERVICES ITS INCEPTION, HISTORY AND FUNCTIONS.

By COLONEL D. M. F. HOYSTED, D.S.O.

FOR some little time previous to 1910, it had been felt by responsible R.E. Officers that the authorised method of carrying out Works Services and the Incidental care of W.D. Property was not wholly satisfactory, and that the Army was not obtaining the best possible value for the public funds allocated to those works.

The writer's previous experience in the North Aldershot Division had probably been matched in many other stations.

The Field Company, in which he was a newly-joined subaltern, after a year's experience at the Curragh, was moved to Stanhope Lines: the Company was on the lower establishment and the numbers were so depleted that, when the Sappers were on parade and the specially employed men had been dismissed, it was difficult for the uninitiated to tell whether the dismounted portion was advancing in line or moving to a flank in fours. The Captain was placed in charge of the North Aldershot Division, and when we arrived to take over, we found that our predecessors had already left the station, and we were informed by the Division Clerk that we need not expect to stay long, as the Division officers were changed every couple of months or so.

The writer was much impressed at the time by the long hours worked and the faithful service rendered by the Military Foremen of Works, upon whose shoulders nearly all the Divisional work seemed to have lain hitherto. It is a worthy tribute to them that we found that the work was flowing on satisfactorily without let or hindrance under the circumstances which formed our experience. There was not the faintest hint of misplaced confidence.

Responsibility sat lightly on the D.O. and the Sub-D.O. in those days; indeed, upon some others it seemed to sit more lightly still. A works bill had merely to satisfy the Paymaster, and then it probably languished among the cobwebs for a period of years before being finally disposed of.

But as it became realised in high places that many R.E. Divisions never had a chance of the blessings of continuity in organization, a Committee was appointed by the Secretary of State for War in 1910 to enquire into and report upon the best means of improving this

undesirable state of affairs. Their report was issued in due course, and one result was a proposal for the institution of a strict audit of all Works Services from a technical as well as a financial standpoint, the further to increase efficiency and economy.

At first it was suggested that the staff for this duty should be under the direct control of the Financial Secretary, in order to establish its entire independence, and that its duty should be to post-audit in detail such proportion of the Contractor's bills as might be deemed desirable, such audit to include test measurements, with power to call for all plans, specifications and estimates at any stage of the work, and also to check measurements during the actual progress of the work, if considered advisable. The Committee attached the very greatest importance to this recommendation, as only a check of this nature could bring home responsibility, which was the underlying principle they had in mind. It was felt that most of the defects of the existing system had been seriously aggravated by the absence of such outside and independent examination.

After many conferences and discussions it was decided to bring into being a small Technical Audit Branch, and to ensure its absolute independence of action, without divorcing it entirely from all touch with the Branch responsible for the execution of R.E. Works Services, it was placed, not under the Finance Members, but under the M.G.O., so as to function as a separate Branch independent of his Directorates.

The new Branch was to operate under a Chief Technical Auditor, and the first holder of the directing post was to be Col. Stuart Davidson, C.B.E. (late R.E.), who was specially selected because of his intimate knowledge and experience of Works Services and for his keen discrimination, which would enable him to establish the necessarily somewhat difficult relations between his staff and the Directorates of other Branches, whose bills would come under his review. It was stated that the duties of the new Branch would be taken up gradually and the staff expanded to keep pace with the added business of audit.

As a beginning, the Director of Establishments (C. 4) was asked to supply one clerk, an ex-R.E., who had served as R.E. Clerk in a Division Office as well as in a C.R.E.'s Office, who was a competent typist, and could organize the clerical work of the Branch. As an item of interest, he has been with us until the end of last year.

The necessary Treasury sanction was received in due course, and on the 18th September, 1913, the Secretary to the War Office issued a circular to all Commands notifying the G.O's.C. that a separate Branch of the War Office had been created, under the M.G.O., for the purpose of undertaking the technical examination of Works services. The title was altered from "Technical Audit" to "Technical Examination Branch," and its principal duties were stated to be :—

A. To visit works and make examinations of Works expenditure.

B. To test measurements during the progress of the work.

C. To examine bills for Works Services from a technical point of view after payment.

The duty of the Branch was to test whether the quantity and quality of the various classes of work set forth in the particulars (Bills of Quantities, Schedule of Prices, Measurements, &c.), on which payment is claimed, do, in fact, fairly represent the quantity and quality of the work actually executed. It was intended that the Branch should carry out its duties in close touch with the Local Audit Staff of the Command. It was also explained that the functions of the Branch do not interfere with the free exercise of the powers of the G.O.C. and his subordinates, nor relieve them from their respective responsibilities in regard to Works Services, nor do they include any enquiry into the suitability of the designs, specifications, &c., nor any examination of the quality of the workmanship or materials, except in so far as may be necessary to determine whether the proper description or Schedule Item is quoted and the proper price charged under the contract. But, in the event of the quality of the workmanship or the materials being in dispute, the Branch will pay special attention to this point.

At the end of 1913 and the commencement of 1914, the procedure to be followed was hammered out by the C.T.E. to the satisfaction of the Finance andAccounts Branches, and the new Branch began to function with one Command; the idea being that the remaining Commands should be drawn in as the C.T.E. gained the necessary experience, and as the Treasury authorised the required increase of staff.

As technical errors began to come to light, and it was found that varying sums of money were due to or from the Works Contractors in consequence, the question of re-adjustment came under consideration. This was not envisaged in the initial procedure, which was not intended to relieve in any way the local staff from its responsibility for the correctness of Works bills passed for payment. It was felt that the T. E. Branch was not meant to form part of the ordinary machinery for checking the correctness of Works bills, but to be a separate and independent means of testing whether the ordinary machinery was working efficiently. It followed that, beyond pointing them out for future guidance, no action was originally contemplated for re-adjustment of minor mistakes discovered in the course of the scrutiny, unless they were so numerous as to raise the query of inefficiency or carelessness, or were of such a character as to involve important principles.

Later on, the inevitable alternative to the recovery from a contractor of an overpayment, when such reparation was refused by him or denied by the terms of the contract, suggested itself in the form of penalising the responsible officer or W.D. employé who could not give a satisfactory explanation of the cause of the blunder. It was provided that, in such cases, the whole controversy should pass from the purview of the Examination Branch to the G.O.C. the Command, who could take such disciplinary action as he thought fit. Later on, the disorganising effect of such a system was demonstrated and the public was forced to be content with restitution from the Contractor, as it was everywhere realised that mistakes in such technical matters are due to errors of judgment or want of experience rather than to other causes.

Before August, 1914, the staff was increased to :—

1 Chief Examiner, 2 Examiners, 2 Assistant Examiners, 3 Surveyors' Clerks, and 2 Clerks; but after the outbreak of war the numbers were gradually increased to :—

1 Chief Examiner, 2 Examiners, 6 Assistant Examiners, 15 Surveyors' Clerks, and 2 Clerks.

This large increase was due to the growing volume of work entailed in the measuring, abstracting, checking, etc., of the various encampments constructed for the occupation of the New Armies. After the signing of the armistice the staff was progressively decreased till the pre-war establishment shown in the above paragraph was reached early in 1919, and has remained at that number, which is less than half the size originally contemplated.

During the Great War the staff of the Technical Examination Branch was asked to assist in reporting upon works in progress, especially those large building schemes for camps which were undertaken on the agency system. This duty was of a most onerous and unpleasant nature, as the methods sometimes accepted by the local authorities concerned, in order to save time, as they thought, were too often the cause of large and preventable expense, while their anxiety to provide the accommodation at an early date was sometimes abused by biased persons, with the result that some processes were open to the most strenuous objection.

As a consequence of these extraneous duties, the post-audit of bills began to fall into arrears. And as bills were at times not received by the C.T.E. for a year or so after payment, steps became essential to make up the leeway that had gradually accumulated. This lag was so marked at one time that a suggestion was made for all bills previous to April, 1919, to be neglected, and a fresh start made on bills paid after that date. Happily this hiatus was rendered unneedful after a conference held at the W.O. on 2nd June, 1920. The Schedule of Prices was revised, responsibility for the accuracy of bills was re-notified to Commands and alterations were made in the initiation of

abstract and bill, as in the recognised procedure for checking and signing them throughout their passage. As an example of the delays that often occurred at this period, the following may serve :—

Date of completion of Service	1.10.15.	
Bill signed by contractor	10.5.16. . . .	7 months
Bill signed by D.O.R.E.	20.2.17. . . .	9 months
Bill signed by C.R.E.	24.7.18. . .	17 months
Bill recd. by C.T.E.	2.20.	19 months

The gross amount of this bill was over £3,000; the nett amount, however, was nil, as the contractor had already been overpaid on account during the progress of the work. One of the unsatisfactory results of such delay is the natural tendency to pass a long outstanding account eventually without proper check, which may, indeed, have become almost impracticable owing to changes in personnel and other circumstances.

The number of bills which had to be examined each year during the war was very large, involving expenditure running into millions. At the same time, contracts were so loosely framed that the percentage of total overpayments actually recovered from contractors in 1919-20 was only 11%. As a basis of comparison, the report for the half-year ending 31st March, 1926, discloses recoveries obtained which yield a ratio of nearly 50%. To give full value to this improvement it should be realised that the amounts recovered can never rise to balance the overpayments concerned, because in so many cases recovery is barred by the terms of the contract.

It will have been seen that the total time that had elapsed between the actual completion of the work and the receipt by the C.T.E. of the bill mentioned above was four years and five months. At a conference in 1920 it was stated that the average time for this journey was anything up to eighteen months. To-day it is nearer five months, which will be still further reduced in the near future. A suggestion has often been made that the labours of the Branch would be of greater value if the system of post-audit were changed to some form of check dealing with current work, and thus rendering expert assistance available to executive officers: but this was not at all the opinion of the Committee which brought about the formation of the Branch. It was undoubtedly and whole-heartedly brought into being to fulfil a long-felt want by providing a technico-financial check, thorough, and therefore not subject to a time limit, and having some of the following subjects :-

A. The enforcement of correct and economical procedure in regard to the execution of contracts, measurements, pricing and works accounting generally.

B. To promote a reasonable appreciation of their responsibilities in these respects in those persons immediately concerned.

C. To bring to light and point out errors and excuses for future guidance in similar debatable queries.

D. The prevention of collusion.

E. The deterrent effect upon contractors and others, who know that even when an account has been purposely left till the end of the financial year, and then successfully hurried through to payment on a carefully conceived psychological plan, that same account will come up for scrutiny of which the essence is care, and under conditions which do not depend on time.

F. To keep foremen of works up to the mark.

As post-audit is its object, the staff may be a comparatively small one and need not interfere in any way with the free hand of C.E's. and C.R.E's. in deciding details of their schemes; whereas, if its duties hinged on pre-audit, it must of necessity be large, in order to keep pace with a vaster amount of work, and, furthermore, it could not fail to undermine the responsibilities of the local authority. This design is apparent from the chief defects of the system in vogue before the introduction of the present method of examination after payment, i.e., that the old system was ineffective because it was insufficiently thorough, and it was impossible to carry out a pre-audit sufficiently comprehensive and conclusive without delaying the payment of bills to a prohibitive extent, and without vastly increasing the staff.

Another vital requisite for the technical Branch was to secure independence of opinion, together with adequate support. Though working in close touch with the D.F.W., the D.B.C. and the Works Finance Branch, it could not act under the orders of either of them without sacrificing that wholly unbiassed and unrestricted purpose, the rock upon which its very being is founded. All these indispensible characteristics were secured by placing it directly under the Master General of the Ordnance.

One of the first tests applied to a new service is the financial one, and what is looked for is the resulting financial saving, which expression is eagerly pounced upon by critics when that saving is meagre in terms of sterling, in their attempt to demonstrate the ultimate debit balance due to the Branch. But it is obvious that this financial balance cannot be expressed in figures alone, and it must be realised that such examples as can be quoted here do not form the true criterion of the ultimate saving in money, when considered apart from all other factors, such as losses due to overcharge which have been prevented.

It is true that the only direct financial saving lies in the sums recovered from contractors. But this really subordinate point was not even considered amidst the reasons which occasioned the birth of the Branch; indeed, it is not so very long ago when the recovery of overpayments was not even provided for amongst the terms of the old Triennial Contract. At the present moment it is definitely legalised

only in the Term Contract for Artificer's Works, a descendant of the older agreement. It is excluded from the other contract forms for R.E. Works after payment of the final bill.

The value of re-imbursement from contractors rests less in the amounts recovered, which are often individually small, than in the deterrent effect of the reminder to the contractor that his computations have not only to pass the local staff, or escape their notice when hurried through at the end of the financial year, but are subject to detailed investigation by independent expert technical examiners. This also forms a further protection against the possibility of collusion between persons responsible for the initiation of the bill, who are themselves experts.

On the other hand, indeed, contractors are beginning to realise that adjustment under the terms of the agreement will also be made when they have been underpaid, and this impartiality of restitution is bound to have its beneficial repercussion in the acceptance, on more favourable terms, of future contracts for Works.

When affairs had begun to resume their normal state after the war, there arose a desire that some form of results should be produced and published, both to indicate the lines on which progress was being made, and to ensure that the experience gained might be placed at the disposal of the originators of future bills for Works Services. The information culled from the errors of others might thus be made use of so that the subsequent volume of observations might ever be on the wane. The method arrived at by a process of exclusion consisted of a comparative table of percentages showing the comparison between the number of observations made and the number of bills selected for examination. And this hope of the committee is being steadily realised, since the general value of appreciable errors has diminished very considerably. Attempts are being made to consider results from the positive view point, and show the percentage of accurate bills to the total, a method that may produce a more satisfactory impression. It is very difficult to show a direct measurement of the improvement in the general position which has resulted from the suggestion of the Committee, nor is it possible to average the percentage figures over longer periods than the half year, because the areas and importance of districts have varied considerably from time to time, and have not even yet settled down to their final conditions.

It is therefore impossible to work out and maintain a convincing "batting average" for districts. It would only be correct for the United Kingdom as a whole, since the secession of the stations in Southern Ireland, and even then is subject to the confusion occasioned by the residue of War Services which are gradually being closed down.

At present the scope of the examination is confined to Works in the United Kingdom, though it is felt that all stations abroad might,

with advantage, be embraced gradually in the organization. A beginning is to be made with the Far Eastern Stations as from 1st March, 1927.

Some years ago, when the volume of bills was very large, the percentage that could be checked by the small staff authorised was much less than it is now. Consequently, the number of bills with errors that remained unchecked was relatively greater, and the only errors that could be observed upon were for relatively larger amounts. Now that the total of bills received is smaller, approximately equal to pre-war days, the percentage checked has gone up considerably, for the staff, though small, has remained constant.

As a consequence, the number of errors which remain unchecked has diminished appreciably, and it follows that the check is more severe. The sieve has a smaller mesh, and the average financial value of an error is correspondingly less. The efficiency of the check and the satisfactory results in financial terms are, therefore, increasing, though this may lead the sufferer to cavil at what he deems a pinprick: in fact, observations involving trifling financial errors are only made to draw attention to some principle which appears to have been overlooked. But it also points to a much more desirable conclusion, namely, that the number of errors is curtailed, and we are obtaining better value for our money. This in itself is a cause for rejoicing, especially during the lean years through which we are called upon to pass.

Medical officers who look after the health of great cities pride themselves most when the incidence of disease and epidemic is at a minimum. Their efficiency is in inverse proportion to the amount of disorder. Similarly, the smaller the total of street accidents, the more competent is the traffic control. The less talk of disease and misadventure, the more efficacious must be the unseen work of these preventive organisations. Even in the last four years the maximum percentage of total observations to number of bills examined, for single districts, has fallen from nearly 600 to 100, and should soon sink below the 50 line. And the percentage, in monetary value, of total expenditure on R.E. Services, to the bills observed upon, i.e., the measure of health of the community, has already been raised to a very large figure, while the total number of Observations is gradually falling.

Now, the conditions of Works Contracts are ever so much more complicated abroad than they are at home, which naturally increases the opportunity for error. If, therefore, all bills from foreign stations were also subjected to technical check, similar beneficial results would be attained for those stations, and a further increase of return would be ensured for the funds available.

THE COAL PROBLEM AND LOW TEMPERATURE DISTILLATION.

By CAPTAIN G. MACLEOD ROSS, M.C., M.ENG., A.M.INST.C.E., R.E.

The possession of vast natural resources of coal, amounting, it is estimated, to no less than a further 1,000 years' supply at present rates of consumption, has been the basis of the industrial prosperity enjoyed by this country throughout the nineteenth century. Since the year 1800, when only 10,000,000 tons of coal were raised, until 1913, the peak year of coal production, when 287,000,000 tons were mined, the coal industry has gradually expanded. Since the conclusion of the war it has fallen on evil days, and the state of depression has naturally been reflected in the many trades and industries which rely on coal.

Expressed in military terms, the coal industry of Great Britain is at a low ebb, because it lacks an up-to-date doctrine, and consequently it cannot produce the coal at a price to meet the economic demand.

During the war the mines were to all intents and purposes nationalized, and it can be said in mitigation of the present plight of the industry that this had the effect of blinding it to the conditions which would pertain, and under which it would have to operate, when the controls, which are alone possible and effective in war, were raised.

The average individual is rather apt to lay the cause for the comparatively sudden failure of the coal industry to run on economic lines at the door of oil fuel. The report of the Royal Commission on the Coal Industry [1] has indicated that this is far from being the whole truth. Here it is clearly shown that the main source of trouble lies in our export trade, which has dropped from 98,000,000 tons in 1913 to 43,750,000 tons in 1920. Of this decrease, only 3,000,000 tons is attributable to the change-over to oil fuel. Foreign consumers of coal are not using less than they did in 1913; on the contrary, their consumption has in most cases increased. Nor is this decrease in export trade due to the vast development in the use of electricity and the utilization of water power resources abroad. The main reason for our depression is that other European countries have now, through force of war circumstances, become largely self-supporting, which means that they can raise coal within their own territory more cheaply than we can supply it.

1 Cmd. 2,600.

It will, therefore, be clear that the consideration of any new process whereby coal can be changed into a gas, an oil and a solid fuel, is of universal interest. On the commercial success of such a process the coal industry may legitimately look for an increase in the demand for coal, with the consequent increase in price which such a demand will create, whilst the industries of the country may look for a lessening of their fuel bill.

The foregoing aspect is, of course, of importance to the Fighting Services of the country; nevertheless, it is the possibility of obtaining from native sources the fuel on which the Services rely for their mobility that makes the problem a peculiarly personal one.

The distillation of coal readily falls into the two categories of high and low temperature processes. The former is in the hands of the coke oven and gas industries, which between them carbonize annually some 37,000 000 tons of coal to obtain, principally, metallurgical coke and town gas. The by-products of these processes are tar, sulphate of ammonia, and sulphur.

Low-temperature carbonization processes are undoubtedly those which, of late years, have attracted most attention in this country. Speaking at a luncheon on October 20, 1926, given by the Institution of Fuel Economy Engineers, Sir Robert Horne referred to a process of low-temperature carbonization of coal by which might be obtained liquid fuel and oil, together with gas of a high calorific value, and a residuum of solid fuel of special value.

Motor spirit, Diesel oil, and fuel oil are obtainable by this process, and Great Britain might thereby become independent of the well oil imported from foreign countries. This would mean fewer chances of political misunderstanding leading to war, and a possible reduction of defensive commitments necessary to preserve the source of imported oil, and safeguard the line of supply in time of peace. In war it would mean increased independence of action for all the fighting services, since the source of fuel would be at home.

The gas and the solid fuel obtainable are mainly of interest from an industrial and domestic point of view. The possibility immediately arises for the bulk generation of gas at the collieries, and its distribution by means of high pressure long-distance mains [2] to the chief industrial and agricultural areas. When such distribution in this country comes to be considered, it is found that in no case need a single transmission line be more than 75 miles in length to reach the various areas from the adjacent coalfields. Such an undertaking, although unknown in this country, has been successfully practised in America and Germany for some years. In Westphalia, since 1913, a pipe-line 270 miles long, and ranging in diameter from 16 in. to 8 in., has supplied 2,500,000 people. In the United States, the

2 Article in "Gas Journal," 10/2/26.—"Gas Supply in Bulk by Long Distance Transmission," by Harald Nielsen.

Western United Gas and Electric Company, of Aurora, Illinois, has a high pressure main 85 miles long, supplying a distribution system of 1,300 miles of pipe line, the maximum pressure used being 95 pounds per square inch.

At the present time, when much is being heard about super-power stations and long-distance transmission, it is interesting to compare how much more favourably the gas industry stands as regards the problem of long-distance high pressure transmission than does the electricity supply industry. The main obstacle to high-tension, long-distance electricity transmission is not only that the main high tension feeder must be provided, but that the low tension distribution system in countless villages and towns has to be built up. It is this aspect of the electrical case which is utilized by opponents of the super-power stations' scheme to show that the country is not yet ready for such treatment, and that before it can be a commercial success the small power station must be exploited to do the spade work of providing the low tension distribution system, after which the high tension transmission line, supplied from a super-power station, will come into its own.

Now the gas industry already possesses all over the country the necessary low pressure distribution systems, and the time is therefore ripe for high pressure gas distribution, should gas generation in bulk at the coal-fields prove practicable as a result of the establishment of some form of low temperature process.

The solid fuel resulting from low temperature carbonization is of such a nature that it will burn in the domestic fireplace without the emission of smoke and, consequently, it offers by its use to improve the amenities of life in our cities. In Manchester the cost of household washing on account of smoke is estimated at £290,000 per annum. The Coal Commission estimated that 3,000,000 tons of soot are discharged into the atmosphere of the British Isles annually, equivalent to 3,000,000 men-days per annum of coal production.

There are also possibilities to be derived from the use of the solid fuel in pulverized form. Owing to its freedom from hard graphitic carbon films, the fuel requires less power to pulverize it than either coal or high temperature coke. Its low volatile content means a possible reduction in the size of the combustion chamber, whilst it possesses a noticeably low ash content which does not fuse. It compares favourably with pulverized coal as regards bulk, and has a calorific value of from 11,000 to 12,000 B.T.U. per lb., depending on the coal from which it is carbonized.

So far no low temperature process has been established on a commercial scale for a period sufficient to enable the claims made on its behalf to be fully tested. Unfortunately, the impression has arisen that it is only necessary to choose the best process, establish it on every coalfield and immediately the air will be cleared,

not only of soot, but of every industrial and domestic fuel problem. This is far from being the case, and the longer the subject is studied, the clearer it becomes that low temperature distillation, like most other industries and processes, will have to be evolved gradually.

The complexity of the commercial problem is to be gathered in part from a consideration of what has befallen the Westphalian high-pressure gas plant. The contracts for the supply of gas were made, having as their price basis the normal requirements and development of the steel trade for oven coke. With the slump in the steel trade came an increase in the gas demand, resulting in the gas having to be supplied at a loss. Here, at once, is the danger in a process which produces oil, gas and coke. At one period the gas may satisfactorily be made to pay for the loss on the oil, but a change in the national requirements may suddenly render the whole process uneconomical.

In order that a distillation process may be a lasting success, it is essential that all three products shall be self-supporting, and that there shall be no making up on the roundabouts the losses on the swings.

It is now proposed to describe at some length a representative carbonization process.

THE L. & N. PROCESS.

Whilst high temperature processes work around 1,000° C., the low temperature processes vary from 400° C. to 600° C.

It is quite impossible to define what exactly constitutes a low temperature process, since the numerous self-styled low temperature processes all work at different temperatures, and all produce different results. Some concentrate on producing fuel of a certain calorific value, whilst others are mainly interested in the resulting gas. The types of retort employed are as variegated as the products evolved; some are externally heated, others use internal heat; one passes steam over with a view to temperature control, whilst others employ paddles to stir up the coal dust and so ensure even heating.

From such an array it is not, however, difficult to appreciate the plant which is simplest and most efficient, having in view the desired end. Nor is it difficult to pick out the system which is capable of expansion to a commercial scale, and therefore capable of handling a large throughput of coal.

The first fact that bears on the system of retorting employed is the penetration rate of heat in coal. At 200° C. to 250° C. this is found to be 0.75 to 1.0 inch per hour. Taking this fact in conjunction with the observation that oil commences to be liberated from bituminous coals at from 200° C. to 220° C., and that above 450° C. no further oil evolution occurs, it is clear that whilst temperature control is likely to be very difficult to effect, it will be facilitated by using small or slack coal and surrounding it with hot inert gases. The economic effect of this is obvious, since low priced slack and smalls

will readily lend themselves to low temperature treatment with little or no expense being incurred for crushing.

The "L. & N." demonstration retort consists of a rotating tubular furnace, 45 ft. long by 3 ft. 6 in. diameter, very similar to that employed in the cement making industry. It is suitably lined with fire brick and fitted with staggered shelves, which turn over the fuel as the retort revolves. The retort is mounted with a slight fall along its length from the hopper end, where the coal is fed in, towards the combustion chamber end. Slack coal is fed in to the retort continuously by means of a suitably sealed screw feed.

The capacity of the demonstration retort is 8 to 10 tons per 24 hours, but it is intended that the commercial unit should be 100 tons per diem, estimated to cost complete £25,000. Speaking generally, gas for firing is supplied by a water gas producer, and is fed into the combustion chamber to which secondary air is fed. The combusted gases pass under a baffle wall, after which a definite amount of gas from the final scrubbers is added, together with a small quantity of steam. The scrubber gas combines with any free oxygen and provides a means of temperature control. The inert gases then pass to the retort at about 700° C., and the normal temperature gradient along the retort is :—At 17 ft. from the point of gas admission, 420° C. At 27 ft., 320° C. At 34 ft., 250° C. Outlet temperature 150° C. to 180° C. The pressure loss in the retort is negligible.

From the retort the distilled gases first pass to a dust extractor, next through two annular coolers, then to a water cooler and condenser. A fan is interposed here to do the necessary exhausting. Passing this, the gases go through a final water cooler and, lastly, to two coke scrubbers. This gradual cooling is employed in order to ensure that no chemical decomposition of the oils carried over as vapour ensues.

The products per ton of raw fuel are approximately 15 to 20 gallons of oil, 2,000 to 3,500 cubic feet of gas of varying calorific value, depending on the retorting system, and 0.6 to 0.65 ton of residual fuel.

It should be noted that, depending on the products desired, the process of retorting will be altered accordingly.

As regards the gas, three main grades can be produced by the process :—

a. A producer gas enriched by the distillation gases to a calorific value of 200 to 230 B.T.U. per cubic ft., suitable for furnace work, steel manufacture, and general industrial purposes.

b. A carburetted water gas. Calorific value 360 to 380 B.T.U. per cubic ft. Suitable for town gas purposes as a diluent or for industrial or manufacturing processes.

c A distillation gas of calorific value of 500 B.T.U. per cubic ft., suitable for enriching town gas, or for long distance

transmission, or in a compressed state for welding and cutting to replace acetylene.

Whilst in each case above mentioned the quantity of the remaining fuel is altered, the quantity and quality of the oil obtained remains unimpaired. In the production of the last mentioned distillation gas, it has been found possible to move the temperature zone of the retort, in which the oil vapour is distilled off, nearer to the point of exit of this vapour. The temperature at the combustion chamber end of the retort is raised so that the gradually advancing coal, having given up the oils in a temperature which is sufficiently low to ensure that no decomposition takes place, is finally introduced into a zone at a temperature of some 900° C., in which it gives off an additional quantity of gas. The gas first removed from the coal is mixed with the gas given up by the residual fuel, the mixture amounting to approximately 7,900 to 8,450 cubic feet per ton of coal carbonized, and having a calorific value of from 495 to 515 B.T.U. per cubic ft., depending on the type of bituminous coal used.

The table below summarizes the laboratory results:

	Scottish Non-coking No. I.		Barnsley Coking No. II.		Doncaster Coking No. III.	
	Gas from Coal.	Gas from Coke.	Gas from Coal.	Gas from Coke.	Gas from Coal.	Gas from Coke.
Cal. Value B.T.U. per cubic foot	730	436	675	394	675	392
Vol (in cubic ft.) per ton of coal ..	2000	5500	3300	4800	2200	4000
Distilling Temp. ..	550°C.	900°C.	550°C.	900°C.	550°C.	900°C.
Vol. of Mixture per ton of dry coal ..	8350 c.ft.		8450 c.ft.		7900 c.ft.	
Cal. Value of Mixture B.T.U. per c.ft. ..	515		507		495	
Oil obtained galls. per ton	21		17.5		21	

By this means a slur usually cast upon low temperature methods by town gas engineers is seen to be partially removed.

It will be readily understood that the gas therm is saleable at a higher price than the coke therm, and consequently from a gas engineer's point of view the test of a carbonization process is the ratio of therms in the gas and the coke—the price obtainable being from 8d. to 8½d. in gas form, and from 1d. to 1.2d. in coke. Town gas undertakings usually produce from 65 to 70 therms of gas per ton of coal carbonized. The normal low-temperature process gas gives only some 22 gas therms per ton of coal. By the method just described it is possible to raise this figure to 43 gas therms per ton of coal[3].

The residual fuel had a volatile content of from 1.5 to 2.0 per cent. only, but it was found to be very free burning and as easily ignitable as with a volatile content of from 8 to 10 per cent.

3 See Appendix.

When producer gas is obtained, the volatile content of the fuel varies from 13.12% for Coal No. I., 10.15% for No. II, and 13.49% for No. III., the quantity of residual fuel varying from 0.6 to 0.65 ton per ton of coal. The residual fuel, although varying as to volatile content, is smokeless and eminently suitable for use in domestic grates, whilst the possibilities of burning it under boilers in pulverized form has already been mentioned.

It now remains to consider the oil which the "L. & N." process produces. The claims put forward are that *true primary oils* are obtained, and the contention is supported by the fact that these oils conform to the tests laid down by Professor Franz Fischer, of Mulheim, for primary oils. In this, the "L. & N." process differs from many other low temperature processes. It is found that the quantity of crude oil obtainable per ton of bituminous coal amounts to from 15 to 20 gallons. The main points of interest regarding the oil are that all the distillates are of the paraffin series, whilst the product from bituminous coals is to all intents and purposes a standard, irrespective of district, coking, non-coking, younger or older coal formation. These primary products are the same, not only in specific gravity, but in relative percentage by weight of fractions and in physical properties. Consequently, not only are the primary oils amenable to the same refining treatment, but, when refined, they readily mix with well oils of similar properties.

That the lubricating oils obtained compare very favourably with highly-priced and well-known oils now on the market is borne out by tests carried out by the National Physical Laboratory at Teddington.

The quantities of refined oils obtained from a large scale test, per ton of Lambton (Durham) coal by the "L. & N." process are set out below:

Light burning oil	0.925 gallons.
Diesel oil	2.190 ,,
Light lubricating oil	1.890 ,,
Heavy lubricating oil	2.020 ,,
Acid oils	7.48 ,,

A total of 14.835 gallons of saleable oils[4].

However, it has been shown[5] experimentally that a further 40 gallons of motor spirit is obtainable from the fuel residuum by means of either the Fischer-Tropsch "Synthol" process or the Badische Catalytic process. The former process starts with the solid carbonaceous residue of the coal distillation from which water gas is obtained. Of the reaction product known as "Synthol" subsequently obtained, it is claimed that 80 % can be used as a motor spirit—the yield from the coke residue of a ton of low grade British bituminous coal, con-

4 Excludes the light spirit from Scrubbers which gives about 1.5 gallons of motor spirit per ton of coal distilled.

5 See articles in the "Gas Journal," June 16th, 23rd, and 30th, 1926, by Harald Nielsen.

taining 7 to 8 per cent. ash and 5 to 6 per cent. moisture, being 40 gallons. Some of the properties of this refined "Synthol" are given as:

Specific gravity 0.828.

Nett calorific value 13,600 B.T.U. per lb.

Road tests give the following results:—

Kilos. run per 100 cc.	"Synthol"	3.0
	Benzole	2.9

Nett calorific value of Benzole used was 17,250 B.T.U. per lb.

An attempt has been made in the foregoing to give a connected account of one of the many processes which may help to solve our present fuel problem. Unfortunately, the commercial aspect, no less than the technical, is extremely involved. Before the former problem can be successfully realized, it is essential that the latter should be completely solved, and the crying need of the moment is for research on a scale of 12 inches to the foot.

It is clear that the primary distillation and the subsequent refinement or treatment in order to obtain the maximum yield of oils of all natures presents numberless problems, the solutions of which are in many cases interdependent, but in the tackling of which co-ordination is most necessary. The magnitude of the complete operation is clearly beyond the resources of a single private firm, and it is confidently to be hoped that the Fuel Research Committee recently set up by the Government will provide the necessary co-ordinative direction, and that the necessary research will be supported by Government funds

APPENDIX.

The percentage of available heat recovered in the normal High Temperature process is:

In the coke 56%
In the gas 28%

The percentage of available heat recovered in the normal "L. & N." process is:

In the residual fuel 71.5%
In the gas 8.3%

The relative thermal percentage as a result of this secondary treatment of the residual fuel is:

Heat in fuel residue 65%
Heat in mixed gas 14.8%

The relative commercial values of the two low temperature processes are, as 1 to 1.23.

The costs ratios of various fuels, taking the raw coal therm as unity and allowing for the greater average efficiency in converting the respective heat units into power, are:

Raw coal . . .	1.00	Diesel Oil . .	1.755	Town Gas . .	4.940
Fuel Oil	2.49	Petrol	6.475	Producer Gas	0.952

THE STEREOSCOPIC EXAMINATION OF AIR PHOTOGRAPHS.

By LIEUT. M. HOTINE, R.E.

Anyone who has a pair of normal healthy eyes can get some sort of stereoscopic impression from a suitable pair of photographs. To appreciate small variations in relief, or to gauge the relative depths of land forms over considerable areas, are, however, matters which require a knowledge of the principles of the subject, a little practice, and some care in the selection and use of the stereoscope.

To the surveyor the subject is of some importance; it is becoming increasingly apparent that he can do very little towards producing any sort of a map by modern methods of air survey without the use of some form of stereoscope, and he cannot know too much of the principles he is applying. At the same time air photographs will often be available for the use of the staff or regimental officer who merely wants to get a general idea of the lie of the land. To do so, he need have very little special knowledge, but it is all to the good if he can acquire, with little effort and as a matter of interest, sufficient information to enable him to know what he is doing. The purpose of this article is to steer a middle course between these two requirements. It will contain three lines of mathematics and only "looking glass" optics, and will succeed in its object if it arouses some spark of interest in the subject.

EXPOSURE CONDITIONS.

Any two photographs of the same stretch of country may be combined in a simple stereoscope to produce an impression of *relief*, provided they have been taken from different view points and in roughly the same plane. The *third dimension* supplied by the combination, or *fusion*, of the two pictures will then be perceptible in a direction at right angles to the common plane of the two photographs. This third dimension will, in future, be referred to as "depth."

To obtain a direct stereoscopic impression of vertical heights, the common plane of the two negatives at exposure must consequently be horizontal. This implies the use of a pair of "verticals" (that is photographs taken with the camera axis pointing vertically downwards), which shall moreover have been taken from an aeroplane flying at a constant height between the two exposures. The

greater part of this article will deal with this, the commonest and most generally useful case, although the same principles are equally applicable to oblique or horizontal axis photographs.

The length of the *base* between the two camera stations will depend, among other things, on the altitude of the aeroplane, and the relative relief of the ground. If it is too small in relation to these two factors, the result will be a weak stereoscopic impression; if too long, various troubles arise in the subsequent examination of the photographs. We shall have occasion to refer later to these questions.

The necessity for the second negative of the pair to be exposed in the same plane as was the first will also appear later. Air photographs, taken on a base length of a mile or so, cannot at present be made to fulfil this condition rigorously, but they can be, in fact usually are, taken with ample accuracy for qualitative examination. For the purpose of instrumental air surveys it is often desirable for various reasons to expose in very different planes; but whether this condition is violated from choice or from necessity, it is at the root of all complexity in processes of photographic survey, where it is usually a question of the *measurement* of stereoscopic images. A complete remedy for the resulting troubles is only to be found in somewhat intricate machines, the main function of which is to reduce the two photographic images to a common equivalent plane, which moreover is usually one of the co-ordinate planes of the survey. For the moment, however, we are merely concerned with qualitative work, and we shall assume, justifiably, that this condition has been sufficiently well fulfilled for the purpose.

Now wherein lies the magic of such a pair of photographs? To answer this question it is necessary to invoke the aid of a little simple geometry.

Suppose that Fig. 1 represents the state of affairs at exposure; the centres of the photographs (or more correctly the plumb points) being at c and c^1. A point O on the ground, at a depth H below either position of the aeroplane, will give rise to images o and o^1 which occupy very different positions relative to c and c^1 on the pictures. The amount of this difference of position can be expressed by the algebraic difference o^1o^{11} of oc and o^1c^1. Designate this difference by the term "stereoscopic parallax,"* and call it p. A glance at a pair of similar triangles in the figure establishes our first line of mathematics, and the Genesis of Stereoscopy:—

* Exception may be taken to this expression for a linear measure on the ground of its confusion with the astronomical term "parallax," which is essentially an angle. In fact, some writers on the subject use the term "stereoscopic difference," for this reason. "Parallax" has, however, already taken such a grip on this branch of surveying that it is perhaps better to retain it.

$$p = \frac{fb}{H} \qquad (1)$$

where b is the length of the *air base*, and f is the focal length of the camera lens (or more correctly the "principal distance" of the camera).

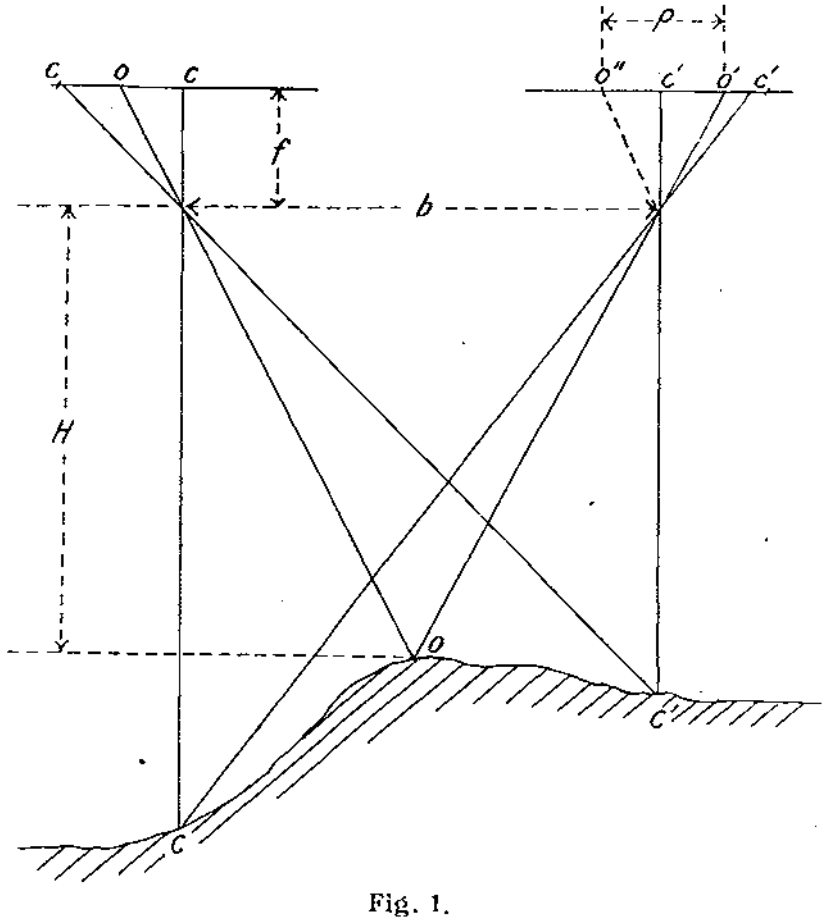


Fig. 1.

This simple relation between parallax, which can of course be measured on the photographs, and the corresponding depth of an object below the air base, would enable us to determine vertical heights, *provided* the above exposure conditions had been rigorously fulfilled. Further, objects on a particular contour for which H is constant, have a constant parallax, so that once the appropriate value of H or p has been determined the contour could be traced.

Now suppose that a dead flat plain is photographed, so that H, and consequently p, is constant all over the pictures. The two views will then be entirely similar, and indeed could have been obtained from the same air station by merely decentreing the camera

lens. Such a pair will be found to yield *no* impression of depth in the stereoscope; as might be expected, they will combine to produce the impression of a dead flat plain, and *whatever the actual numerical parallax there will be no indication whatsoever as to the depth at which this plain as a whole lies.* In this particular case we are dealing solely with *absolute* parallax and we get *no* sensation of relief, so that it is quite safe to assume that *absolute* parallax has nothing whatever to do with the phenomenon. It is important to get this idea fixed once and for all. Failure to appreciate the point has led to a great deal of nonsense being written on the subject. For instance, it has been asserted that stereoscopic fusion becomes impossible where parallax exceeds a certain amount, and that in consequence it is necessary to use short bases in order to reduce parallax. This is to throw away one of the greatest advantages of photographic survey from the air.

On the other hand it will be found that a stereoscopic impression is invariably obtained where a sufficient *difference* of parallax exists between various images, that is, where the two pictures are *dissimilar* in form. The whole effect is in fact entirely relative; we do not, cannot, estimate the absolute depth of a single object stereoscopically; we can only *compare* its depth with that of a neighbouring object.

The more of this *difference* of parallax we obtain, under practical conditions, for a given *difference* in heights on the ground, the better will be the subsequent stereoscopic effect. The mathematician will at once take this hint to *differentiate* the above formula to see how this end may be attained by varying the exposure conditions. Other things being equal, he will find that the stereoscopic effect can be increased by:—

(*a*) using a long focal length.
or (*b*) increasing the base length.
or (*c*) flying low, in which case the increment in parallax difference varies inversely as the *square* of the reduced flying height.

These mathematical conclusions are entirely supported by practical results, but there are nevertheless other controlling factors. A long focal length implies a bigger and heavier camera, or alternatively a restricted field, and will seldom be permissible in survey operations, where economy in time or money is so essential. The base length for a given height is fixed independently of all other considerations by the amount of ground to be covered in the area common to a pair of photographs. To cover a large area economically this implies an *overlap* of just over 50%, so that we can seldom achieve much by juggling with base lengths. In peace-time topographical surveys, the airman will normally be asked to fly as high as he can reasonably climb, in order to save money by cramming

much country into one picture. In war, the same condition will usually hold for other and more obvious reasons, and that will dispose of the question of flying height. In the majority of cases we must accordingly be satisfied with what we can get in the way of parallax differences, and attempt to make the most of them in the stereoscope. Nevertheless, if the immediate end is the examination of minute differences in relief on the ground—and this will frequently be the case in Intelligence work—the above drawbacks to these means of increasing the stereoscopic effect must be faced.

The Stereoscope.

Hold a sheet of cardboard on edge between the two dots in Fig. 2, so that one dot only is seen by each eye, the other dot being hidden by the cardboard. Place the head opposite the dots in the "square on" reading position and attempt to look *through* the paper. If anyone has difficulty in performing this feat, let him make two similar marks on a window pane and actually look beyond them to some object outside. The two dots will move inwards and will eventually come together and *fuse stereoscopically*. To anyone unaccustomed to stereoscopic observation it is quite likely that this single fused dot will appear blurred; if so, maintain the dot in fusion by an effort of will and look back at the paper, thus bringing the image into visual focus. It will also help if the dots are not placed too close to the eyes.

Fig. 2.

Next, keep the head still, concentrate on the fused dot, and twist the paper round slowly. The eyes will first experience a feeling of strain, the dot will then become blurred, and will finally go out of fusion. For easy fusion, in fact, it is necessary for the line joining the two dots to be parallel to the "eye base," that is to the line joining the centres of rotation of the eyes. It will be seen, however, that there is a considerable visual tolerance in this respect.

There should now be no difficulty in understanding the function of the simple stereoscope. Both photographs are first oriented so that the two corresponding photographic images of each object on the ground (exemplified by the two dots in Fig. 2), fall on lines parallel to the "eye-base"; the optical system of the stereoscope in effect shifts the two photographs laterally so that these corresponding points lie quite close together, at the same time ensuring that each eye sees only one picture; and the eyes complete the process by breaking down the remaining separation of these corresponding points and fusing them. The result is the appearance of a single picture in stereoscopic relief.

We shall now consider each of these steps in greater detail.

Orientation. Return for a moment to Fig. 1. The points c, c^1 will correspond to points C, C^1 on the ground, represented, say, by a tree or some point in the middle of a field. These same trees, or what not, will be imaged on the *other* photograph of the pair (provided we have 50% or more overlap) at c_1, c_1^1. The lines $c\ c^1$ $c^1c_1^1$, on the photographs may be known as the *photographic directions of the air base.*

The mathematician may show, for his own amusement, that, whatever the relief of the ground, parallax displacements are always in this direction. In other words, if we superimpose the two photographs with the directions of the air base coinciding, any two corresponding images will lie on a line parallel to this direction. The mathematician's word may be taken for it, but we must recognise the fact.

This then is the condition which must be fulfilled in orienting the two pictures; the two directions of the air base must be made to coincide in the superimposed images formed by the stereoscope, and this common direction must moreover lie parallel to the eye-base.

Neglect of this condition is the most prolific source of trouble in stereoscopic work. At the least it entails a loss in relief where parallax differences are small. When parallax differences are larger, and a loss in relief is of less consequence, the result, as was seen in the dot game, is eye-strain, blurring, and in extreme cases a breakdown of fusion.

The usual method of orientation is the reverse process of juggling the prints until they fuse easily, and for rapid "look-see" work this is quite sufficient. If, however, the object is to appreciate relative relief over comparatively large areas, or to contour the prints, a rather more refined procedure is necessary. The "principal points" of the photographs, which for the moment may be confused with the plumb points c, c^1 of Fig. 1, will invariably be marked in pictures taken with surveying cameras. Their correspondents c_1, c_1^1, on the other photograph of the pair may be identified and marked, and the actual directions of the air base drawn in. Correct orientation will then be obtained by making these two lines coincide under examination in the stereoscope. A more rapid and accurate method will, however, be given later under the heading of parallactic grids.

It is very necessary that the two prints should be placed in the right order. First superimpose them with the common area very roughly in coincidence. Then, provided that no inversion is introduced (or more correctly no odd number of lateral inversions are introduced), by the stereoscope, the right-hand picture as thus placed must be seen by the right eye. If this order is reversed, the result will be inverted or *pseudoscopic* relief, the landscape being

in effect, turned inside out. Not everyone will see this effect, but it is nevertheless there, and may be shown up by various artificial means. In such cases, the majority of observers will get no sensation of relief at all.

Optical Construction. If the dot game is repeated with an increased separation between the dots it will be found much more difficult to fuse them ; in fact it is only after considerable practice that a separation of more than 2 inches can be broken down without artificial aids, and in no case can this separation exceed about 2½in. With the large prints common in air photography, however, it is seldom that corresponding points can be placed as close as this without actually placing one photograph on top of the other, and thus obscuring it, so that some optical contrivance is required to reduce the separation within fusible limits.

There are various means of achieving this end. The commonest (Fig. 3), is the Brewster type of stereoscope, in which prisms or half lenses are placed in front of the eyes. Rays of light from the photographs aa, bb are *deviated* through these prisms or lenses with the result that the pictures appear to lie at a^1a^1, b^1b^1. A slight magnification (in the case of lenses) may also be introduced in the process.

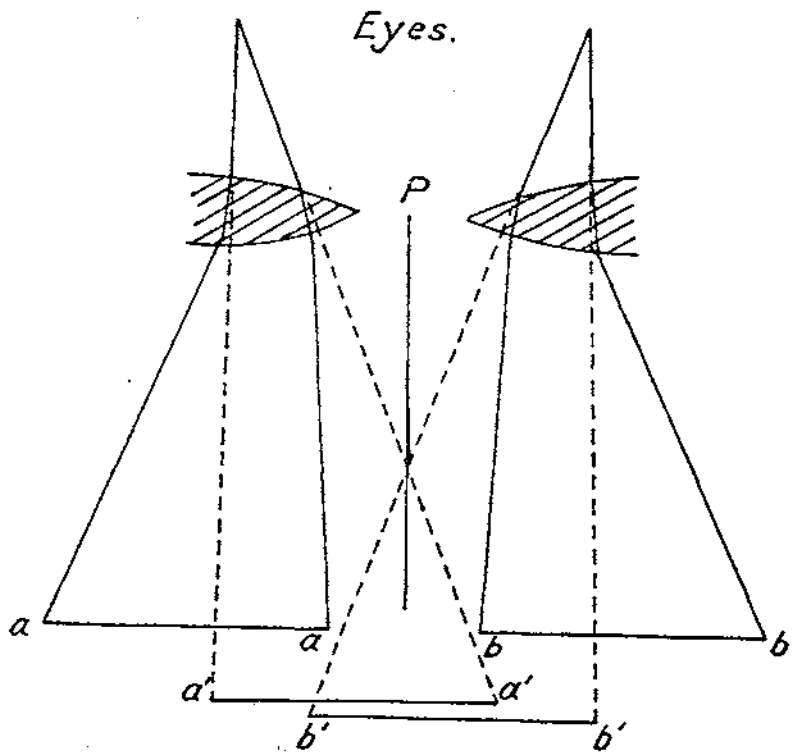


Fig. 3.

A partition P will ensure that only one picture is seen by each eye, but if this is omitted the only result will be that satellite photographs are seen on each side of the central fused picture.

Alternatively, we may follow the original Wheatstone stereoscope and use a pair of parallel mirrors MM^1 (Fig. 4), inclined at 45° to the common plane of the photographs.

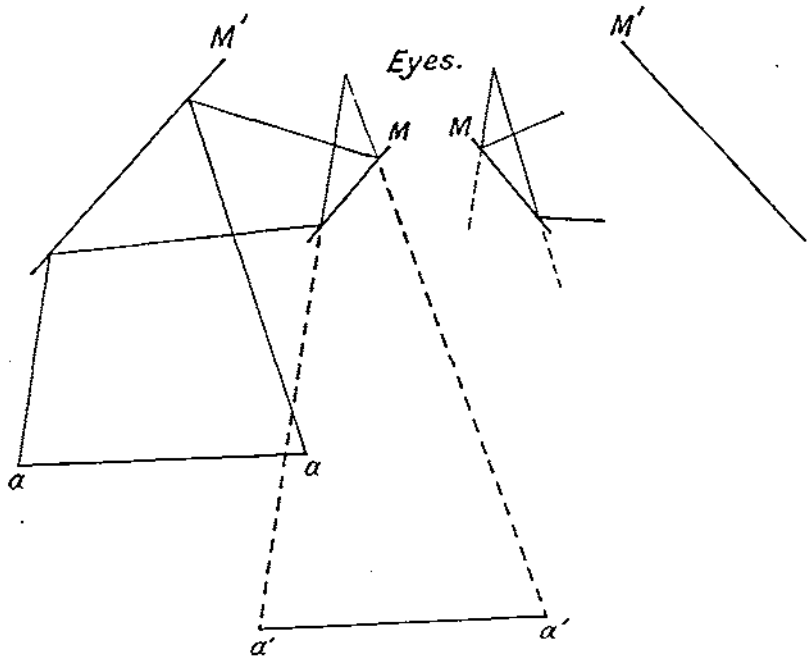


Fig. 4.

There are countless variations of these two basic types, differing mainly in name, and anyone possessing a nodding acquaintance with the laws of reflection and refraction will have no difficulty at all in understanding the magic of any particular make. Generally speaking, instruments of the first type are optically imperfect, in that they introduce various distortions which may result in eye-strain, but they possess the merit of portability. The second type are sound optically, are not always easily portable, and frequently make the mistake of forming the virtual images a^1a^1, b^1b^1 at too great a distance from the eyes. The significance of the latter drawback will appear later. These disadvantages, and others, are however largely overcome in the new Topographical Stereoscope by Barr and Stroud, a photograph of which is reproduced (Fig. 5).

This instrument is of light construction and shuts up automatically into a small hand case. The virtual images are formed at a

fixed distance of 12ins. from the eyes, a distance which is found to be most generally suitable for topographical work

Fig. 5.

Only one other variation is described in some detail, not, however, because it introduces any modification in rock-bottom principle.

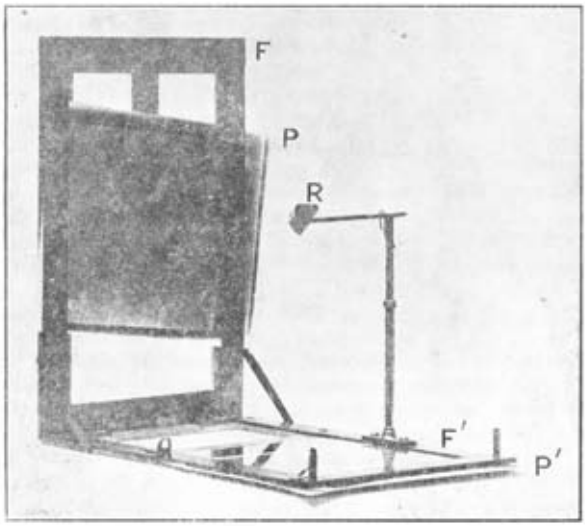


Fig. 6.

MAR TOPOGRAPHICAL STEREOSCOPE

The experimental model of this is illustrated in Fig. 6. The photographs P, P^1 are carried under spring steel strips on the frames F, F^1, which shut up like the leaves of a book when the instrument is not in use. P^1 is viewed directly with the right eye, while P is seen by the left eye through the *roof prism* R, the function of which is to deviate the image of P through 90°, so that it appears to lie in the same plane as P^1. At the same time the prism totally inverts P, so that, in setting, P must first be turned round through 180° in its own plane. For the better perception of *local* relief, the distance of the eyes from the photographs is purposely kept down to about 8ins., which is normally supposed to lie within the closest distance of distinct vision. If any trouble is experienced from this cause, the observer should wear a pair of low power convex spectacles in addition to any reading glasses he may normally use.

Visual Factors. It is clear that all the stereoscope can do is to bring the two photographs together so that certain pairs of corresponding points will coincide; from the very fact that the two photographs must be dissimilar, the stereoscope cannot possibly bring *all* pairs of corresponding points into coincidence, so that there will, in general, be small differences left for the eyes to break down.

Suppose that o, o^1 (Fig. 7) are such a pair of corresponding points in the virtual images formed by the stereoscope, the centres of rotation of the eyes being represented by E, E^1. Then, as a matter of experiment, it is found that once the two images o, o^1 have been fused in the manner indicated above, the effect is the same as that produced by a single image O lying in space at the intersection of E o, E^1o^1. Each pair of corresponding points o, o^1 could, in fact, be replaced by single points O, and we should be none the wiser. Where there is a *difference* of parallax in the photographs, the separation oo^1 will vary for different parts of the pictures, with the result that the equivalent points O will appear to lie at different distances from the eyes, thus producing the effect of an actual solid relief model of the landscape.

Exactly how the eyes, or the brain, are able to receive and register this impression of a single object lying in space are questions for the physiologist or psychologist, and it must be admitted that neither has yet produced a reasonable explanation. Such questions need hardly concern us, however.

The geometrical construction illustrated in Fig. 7 embodies what may be known as the *principle of ortho-stereoscopy*, originally propounded by Wheatstone a half century or so ago. It is even now a subject of controversy.

For instance, if o and o^1 are separated gradually while being retained in fusion, we can, after a little practice, make $o\,o^1 = EE^1$.

MEMOIR.

MAJOR GENERAL BERESFORD LOVETT, C.B., C.S.I.

Beresford Lovett was born in Paris in February, 1839, the son of the Revd. Robert Lovett, Chaplain of the Marboeuf Chapel, and afterwards Rector of Pickwell in Leicestershire. Young Lovett lived and was educated in Paris until 1850, when he was sent to a private school kept by Dr. John Jardine, at first at Turnham Green, and later at Brighton. Here he was educated until, in 1856, he was given a nomination for the Hon. East India Company's Military College at Addiscombe. On passing out after two years at the College, he was placed 8th in the final examination, obtained prizes for French, Fortification and Survey, and a Commission in the Royal Engineers. After two years at Chatham, where his chief recreation was yachting, he left in 1860 for India, via the Cape, in a sailing ship of 1,300 tons. At that time officers had themselves to pay for their passages to India, and the fare via the Cape was £70 against £120 via Egypt. The voyage to India took 84 days, and on arrival Lovett was posted to the Bengal Sappers at Roorkee, and joined there in October, 1860. After five months at Roorkee, he was posted to the P.W.D. at Ambala, and was employed on bridging on the Ambala—Kalka road and other works; and later, in 1862, he was transferred to Ferozepore, where the arsenal was being fortified in view of possible attack by Russia. From Ferozepore Lovett was moved six months later to the Frontier at Kohat, as Assistant Engineer under Major (afterwards General Sir James) Browne. In those days the Kohat P.W.D. Division extended from Peshawar to beyond Dera Ismail Khan, and here Lovett served for four years, during which he carried out much bridging and road-work, as well as training works on the Indus at Dera Ismail Khan. He must have done his work well, for in this period he more than once received the thanks of Government. It was on the Frontier that Lieut. Lovett studied Persian, a language in which he attained considerable proficiency; and in 1866 he was transferred to Persia for work on Telegraphs under Major (afterwards Col. Sir Oliver) St. John. Persia was a country that always attracted him, and his journeys on Telegraph duty between Bushire, Shiraz, Ispahan and Teheran; and to and from England on short leave, via Resht, Baku, Astrakan, Petrograd and Berlin appealed to his adventurous spirit.

After four years of Telegraph work he was attached, in 1870, to General Goldsmid's Mission to settle the frontier between Afghanistan and Persia in Seistan and between Persia and Baluchistan from Seistan to the sea. The responsibility for the maps and surveys required by the Mission devolved on Captain Lovett; the work occupied some two years, and for his share he was awarded the C.S.I. On its conclusion, in 1872, he proceeded to England for his first period of long leave, travelling home via Baku, Tiflis, Constantinople and Athens. He arrived home about the time of the Shah of Persia's visit to London, and from his knowledge of the language was placed on duty with the Shah's uncle. He returned to India, for the first time by the Suez Canal, in 1875, and was posted as Executive Engineer at Abbottabad, where he had charge of various works scattered from the borders of Kashmir to the Khyber Pass; and of the Grand Trunk Road, including the bridge of boats at Attock. This bridge was swept away by a sudden flood in the autumn of 1878, when the expedition against the Jowakis was moving north, and Lovett's energy in replacing it led to his employment with the expedition under General Sir John Ross. The following year he was again on active service, being appointed Brigade Major R.E. with General Sir Sam Browne's Force in the Second Afghan War; and his services were rewarded with a Brevet Lieut. Colonelcy. On the conclusion of the war he went home on leave, and was then appointed British Consul at Astrabad. While here he was much interested in the oil wells at Baku and wrote letters to the *Times* calling attention to the progress which Russia was making in acquiring them.

In 1883 he was appointed Superintending Engineer at Calcutta, and three years later was transferred to the Military Works Department at Rawal Pindi. In 1888 he was on active service as Chief Engineer with the Hazara Field Force under Sir John McQueen, and was mentioned in despatches and rewarded with the C.B. In 1890 he was transferred to Madras, as Chief Engineer. He was promoted Major General in 1892, and retired two years later.

But General Lovett was far too vigorous a personality in mind and body to allow himself to rest unoccupied. He returned to India in 1897 and interested himself in investigating schemes for generating electricity by water power. He formulated, and worked out in considerable detail, a project for utilizing the water of the Nauti Khud to supply power for the water supply and electric light of Simla; a scheme which, though rejected at the time, has since been largely adopted. He also originated a project to provide 13,000 h.p. on the Jumna in the United Provinces. For this he obtained a favourable concession from Government, and was engaged in further negotiations for the work when the outbreak of war prevented its development.

MAJOR GENERAL BERESFORD LOVETT

Until the commencement of his final illness in 1925, he maintained an active interest in all scientific matters, attending, and speaking, at lectures of the Royal Geographical Society, the Royal Society of Arts, the Persian Society, etc., and studying higher mathematics with a professor in London. He cared little for games or sport of any kind, occupying himself almost exclusively with his work, with scientific studies, and with languages. The latest piece of work he perfected (in 1925), was the construction of a Fahrenheit thermometer, with an extra scale from 32 as zero, so that the temperature above or below freezing point can be read at a glance without subtraction.

Lovett had considerable artistic talent, and some of his drawings, notably those contributed during the Afghan War to *The Graphic*, were published by that and other English illustrated papers. He was also fond of singing and had a true and delightful tenor voice. He had a wonderful memory, and his mind was a storehouse of interesting facts and events. He remembered Paris in the days when the Queen of Cities was illuminated by "reverbères," oil lamps suspended by chains across the streets, he also had clear memories of the Revolution in 1848. When he was thirteen he was taken to see the funeral procession of the Duke of Wellington, an occasion which he never forgot. During the early days in Paris, his father being Chaplain to the Embassy, the family was brought into contact with numbers of interesting people—not the least of whom was his godmother, Lady Harriet Cooper, wife of Mr. Cooper, the owner of Sandringham, (from whom it was bought by King Edward VII, when Prince of Wales). Lady Harriet's first husband had been the famous Comte d'Orsay, one of whose snuff-boxes was given to her godson.

Lovett was a man of most kindly disposition, ever ready to help those in need, cheery and optimistic, given to hospitality; and he had a wide circle of friends both at home and in India.

He married, in 1876, Agnes, daughter of Mr. W. Turnbull Blewitt. She died in 1914.

BOOKS.

WORK OF THE R.E. IN THE EUROPEAN WAR, 1914-19.
MISCELLANEOUS.
Compiled by COLONEL G. H. ADDISON, C.M.G., D.S.O., M.A., M.I.MECH.E.

372 pp. Royal 8vo. 1927. 20s. net. (to members 12s. 6d. net).
Institution of R.E., Chatham.

The publication of this volume completes the Herculean task which

was set Colonel Addison, who is to be congratulated on its successful accomplishment.

The eight volumes he compiled have been all published by the Institution of R.E., and deal with *Bridging, Geological Work on the Western Front, Military Mining, Supply of Engineer Stores and Equipment, Water Supply (France), Water Supply (Egypt and Palestine), and Work under the Director of Works (France)*. There is also another volume on the *Signal Service (France)*, written by Major R. E. Priestly.

The ground covered by this series of volumes furnishes an idea of the vast extent of engineering operations in the field. Truly an "engineers' war" when one thinks also of the work in factories at home on munitions and equipment. The work serves as a history of the war and to some extent as a manual of military engineering, illustrated by maps and photographs. In the volume on *Work under the Director of Works (France)*, which covers such technical subjects as aerodromes, ammunition depots, bakeries, hospitals, hutting, incineration, and laundries, there are no less than 81 folded drawings. Readers who were on the Somme in 1916, or at Arras-Vimy Ridge, Messines, or Ypres in 1917, will find the historical part of *Military Mining* of interest.

Now to come to *Miscellaneous*, which we are more concerned to review. This is arranged in nine sections:—I, The Organization and Expansion of the Corps, 1914-18; II, Organization of Engineer Intelligence; III, Camouflage Service; IV, Concrete Defence Works and Factories; V, Forward Communications; VI, Machinery, Workshops and Electricity; VII, Anti-Aircraft Searchlights; VIII, Inundations; IX, Schools.

Those sections will now be considered in detail—but of necessity only briefly, as the *Miscellaneous* volume has appeared but a few days before the *R.E. Journal* goes to press.

I, Organization and Expansion, deals with the units and establishments of the R.E. prior to the outbreak of war in August, 1914, the expansion of the units on mobilization and after, and the subsequent increase of units—bridging, electrical and mechanical companies, tunnelling companies, searchlight company, labour battalions, and how they were transferred to the Labour Corps in 1917, field survey battalions and their formation, the sending to France of six works companies on aerodrome construction, the conversion of coast defence units into advanced park and base park companies, transportation units, army postal service, etc.

II, Organization of Engineer Intelligence, includes collection and circulation of information on field engineering in our own and allied armies, and with regard to the enemy's methods.

III, Camouflage Service, is arranged in three chapters—organization, production, and execution, providing most interesting reading, with illustrations and sections of various camouflage devices such as the construction of an observation tree, periscope tree, observation posts, covers for machine gun emplacements, etc.

IV, Concrete Defence Works and Factories, describes block shelters, pill-boxes, "Arques" pattern block, machine gun emplacements, layout of concrete factories, etc. Sectional drawings are given.

V, Forward Communications, treats of tracks and roads and the operation of tramways and their mechanical equipment, with plates illustrating

ballast trucks, tramway trucks, trench boards and trench bridges, types of tracks, etc.

VI, Machinery, Workshops, and Electricity, considers aspects of warfare which were not adequately provided for in the original British Expeditionary Force, but which had to be quickly developed as the campaign proceeded, and led to the formation of Electrical and Mechanical Companies R.E. for the Armies, and, later, Army Workshop Companies, R.E. Particulars of the plant in various of the Army workshops are given.

VII, Anti-Aircraft Searchlights, is a summary of their development in France, which was necessitated by the new feature of night bombing by enemy aeroplanes, which began in the latter part of 1916.

VIII, Inundations, discusses the flooding of the Belgian coast by the Allies and the enemy and the use of inundations by the Germans as a defence against the tanks in other parts of the field. Their methods are described, and the advantages and disadvantages of flooding are considered.

IX, Schools, gives a short account of the work done and lessons learned at the Training School in connexion with the R.E. Base Depot and the School of Instruction for Officers Commanding and Second-in-Command of Field units. The Heavy Bridging School is described, not here, but in the volume on *Bridging*, and the Army Mines School is dealt with in that on *Military Mining*. Some of the rules for trench-work are the subject of divided opinion, but they were the views of men who came out of the trenches to be instructors and were, therefore, in touch with the real conditions at the front.

To conclude, all the volumes in the *Work of the R.E. in the European War* contain an immense amount of information, the study of which by members of the Corps is desirable in their own and the Corps' interests. Special prices to members of the Institution of R.E. are granted, and the Institution is to be congratulated on its courage in undertaking so monumental a publication when the War Office, on grounds of economy, could not do so. The work of Colonel Skey in producing the volumes after their compilation by Colonel Addison deserves the commendation and support of members.

MAGNUS MOWAT, Brig.-General, Reserve of Officers,
M.INST.C.E., M.I.MECH.E., M.I.E.S.,
Secretary, The Institution of Mechanical Engineers.

LES OPÉRATIONS EN MACÉDOINE L'EPOPÉE DE DOÏRAN, 1915-1918.

By Lt.-Colonel Nédeff, General Staff Bulgarian Army. Translated by Le Commandant Goetzmann, French Colonial Army. (Librairie Française et Etangére, Sofia). Price 8 fr. suisses.

Lt.-Col. Nédeff, who occupied a very responsible post on the Doïran front in Macedonia during the Great War, published some time ago the history of the struggles between the Allied troops and the Bulgarian

forces. This account has been revised and edited by Major Goetzmann of the French Colonial Army.

The book covers the whole period of the campaign on the Doïran front in Macedonia, from 1915 to 1918. A short preface explains the reasons which forced Bulgaria to join the Central Powers. The book is divided into 6 Chapters. Chapter I gives the famous Ukaze of Tsar Ferdinand with which the operations began. It further indicates the organisation of the two Bulgarian Armies and their objectives. The operations of the second of these armies is given in detail, showing how it had to deal with both the Servian army on the west and the Allied, Franco-British force on the south (1915).

Chapter II deals with the operations in 1916. It refers to the stoppage of the Bulgarian troops on the Greek frontier as a great mistake, imposed upon the Bulgarians by German strategy and diplomacy.

This Chapter includes a description of the organisation of the Doïran-Vardar position and gives an account of the fighting there from the 9th to the 18th August, 1916.

Mention is made of the 25th English Division in the narrative, but this is a mistake, as the 25th Division was never in Macedonia.

It is interesting to note that only two Bulgarian Battalions and two Companies were engaged in these operations against one French and one British Division, a tribute to the extraordinary natural strength of the positions. The Bulgarian army seems also to have been very short of munitions and artillery.

Chapter III contains an account of the operations during the winter of 1916 and the spring and summer of 1917, including the British attacks on the "Pip" ridge and Doïran in April and May of the latter year. A high tribute is paid to the gallantry of the British troops in these actions, and it is stated that the Bulgarians buried no less than 40 British officers and 2,250 other ranks after the attacks. The present writer was a spectator of these operations, and can testify to the gallantry of the British and Bulgars alike, and to the heavy losses of the former.

The chapter also contains a critical review of the operations from the point of view of the lessons they teach.

Chapter IV describes the operations in the early part of 1918, and divulges the plan of the "Balkan Zug" to the south, which provided for a general offensive, but which was never carried out. To one who was much concerned with the preparations which we made to meet this long looked-for "Mackensen Push," this part of the book is very interesting.

Chapter V deals with the final battles 16th-20th September, 1918, and describes the break through of the Bulgarian lines by Allied troops at Dobro-polé. The author eulogises the successful efforts of the Bulgarian Army, in spite of very bad conditions, in withstanding the assaults of the British and Greek troops against the Doïran-Vardar line.

Chapter VI deals with the Bulgarian retreat, and suggests how the reverse at Dobro-polé might have been retrieved.

The book is illustrated by six good maps and contains also photographs of eminent commanders on either side although, curiously enough, there is no portrait of Sir George Milne, the British Commander-in-Chief in Macedonia.

From a military point of view, perhaps the most important point brought out in the book is the constant struggle between artillery and the engineer and his fortifications. From the point of view of the Britisher, the salient feature is the high appreciation of the energy and gallantry of the British soldier, who is said to have displayed such valour and such astonishing energy. To one who had the honour to serve with the British soldier for some two years of this campaign, this is most gratifying reading. It is high praise, and high praise is always gratifying, but the praise of a gallant enemy is the most gratifying praise of all.

The book has been presented to the R.E. Library by Lt.-Colonel Nédeff, of the General Staff of the Bulgarian Army, and to him the best thanks of our Corps are due, not only for the gift but for the kindly thought which prompted it. It was accompanied by a critical review by Lt.-Col. K. D. Marinoff, also of the Bulgarian General Staff from which these short notes are principally taken.

G.W.

NATIONAL FRONTIERS IN RELATION TO INTERNATIONAL LAW.

By COLONNELLO VITTORIO ADAMI, Historical Section, General Staff, Rome, 1919. Translated by Lt.-Col. T. T. Behrens, R.E., late British Commissioner, Italo-Austrian Boundary Commission. With an appendix by the Translator. 8vo., pp.127. Price 10s. 6d.

Colonel Behrens has rendered a public service by translating Colonel Adami's book on *Frontiers in relation to International Law.* We are, as yet, very far from having emerged from the period of frontier delimitation, if we ever do emerge from it, and since Royal Engineer officers are very much concerned in the matter—for the duty of such delimitation very commonly falls on them—the book in question is one that should find many readers amongst the translator's brother officers.

Colonel Adami deals with the various kinds of boundary, natural or artificial; and, as regards the former class, with mountain boundaries, river boundaries, boundaries on lakes, and sea boundaries. As to artificial boundaries, he discusses those leading along roads, astronomical boundaries, and military boundaries. And then we have, as a sign of the times, aerial boundaries and the question of beaconing an air frontier.

Some more technical chapters are devoted to boundary marks, the delimitation documents, and boundary magistracies.

In the chapter on mountain boundaries, it is very properly pointed out that the crest line of a mountain range is, in general, distinct from the watershed. The author takes, as an exact instance, the case of the Chili-Argentine boundary, on which matter the King of England was asked to arbitrate in 1902. In the treaty between these two countries, which was signed in 1881, it was agreed that the boundary as far south as latitude 52° should be the Cordillera of the Andes. "La ligne frontière sera marquée dans cette étendue par les sommets les plus élevés des dits chaînes (Cordillères), qui partagent les eaux et passera entre versants qui s'inclinent de part et d'autre." Now, the summits are not, in general, on the watershed, and the terms of the treaty could not be carried out in

their original form. It is well known how the King appointed a Commission, and how Sir Thomas Holdich took out an expedition and settled this difficult matter on the spot.

In the chapter on river boundaries we find some sound remarks on the undesirable character of such frontiers. Ahrens is quoted to the effect that rivers do not in reality form boundaries between peoples, "but rather serve as an artery,. . . . . a natural area. . . . .is so bound together by rivers and torrents that the two banks . . . should belong to one nation." Then there is a description of the distinction between the median line of a river, that is the line mid-way between the two banks, and the "thalweg" (blessed word), which is either the line of deepest soundings, or the stream line of fastest current. In the case of the boundary between Bulgaria and Turkey, after the war of 1878, the "thalweg" of the Danube had to be determined, and the President of the Commission proposed that this should be taken as the line most favourable to down stream navigation during the period when the river was at its lowest. Nice problems arise when a river changes its bed, or shifts its line of deepest soundings, or of swiftest current.

Lake frontiers are discussed, chiefly with reference to the Italian and North American Lakes. The latter are dealt with in the same manner as the high-seas. And, with regard to the high-seas, the question of the limits of territorial waters has to be decided. A recent decision of the Hague Court of Arbitration lays down that "concerning bays, the three sea-miles must be measured from a straight line, drawn across the body of water at the point where the body of water ceases to have the outline and characteristics of a bay."

There is, apparently, at present no common agreement amongst civilized nations as to the use of air frontiers, but it is undisputed that the sovereign rights of the State apply to the whole air space which overlies its territory. It is, of course, easy to imagine that it would be undesirable to allow free air traffic over certain areas, and it is not doubted that a country has the right to prohibit the passage of air-craft over, or in the neighbourhood of, its fortifications. But there is no international arrangement on the general question. No doubt this will come, and, when it does, international frontiers will have to be so marked as to be clearly visible from the air.

Generally speaking, the book deals with practice in Europe, and its point of view will be particularly interesting to those whose knowledge of such matters is chiefly derived from work in Asia or Africa. An African boundary, is, of course, a rough sort of thing, as compared with one in Europe. The reviewer, for instance, knows of an African boundary along which the boundary pillars are spaced at intervals of about 20 miles; one pillar, let us suppose, at Chatham, and the next at Woolwich! But these African boundaries will require more exact demarcation in a not distant future, and it will be as well for those who may have to deal with such matters to read Colonel Adami's book, as translated and edited by Colonel Behrens. There is much in it that deserves study.

In conclusion, the reviewer would like to draw attention to the frontispiece which accompanies the first 110 numbered copies. It is an engraving of the Brenner Pass, showing also the two sides of the pillar erected

on the Italo-Austrian boundary at this pass. The Italians have inscribed on their side of the pillar—HVCVSQVE AVDITA EST VOX TVA ROMA PARENS. The Austrians have countered this, on the other side of the pillar, with—FONTES SEIVNGO CONSOCIO POPVLOS. It should be added that it is understood that the inscription on the Italian side was the first to be proposed, and it was then up to the Austrians to find a suitable and friendly reply, as it were, for their side. These felicities give a pleasant idea of the relations which existed between the various nationalities on the Commission, on which Colonel Behrens was the British representative.

C. F. CLOSE.

THE MAGNETIC SURVEY OF INDIA, 1901-20.

Records of the Survey of India. Vol. XIX. Part I—History, Instruments, etc. Pp. 67. Part II—Tables of the Magnetic Elements, pp. 121. Part III—3 sets of diagrams and 9 maps.
Printed at the Geodetic Branch Office, Survey of India, Dehra Dun, 1923.
Price 4 rupees, or 6 shillings and ninepence.

A magnetic survey differs from an ordinary survey much as pheasant shooting differs from firing at a fixed mark. A magnetic chart represents the values of the magnetic elements at a definite epoch, but it implies field observations extending over many years, during which the elements are continually altering. In addition to the secular change, which *may* be in one direction for a hundred years, but which is continually altering its rate, we have the diurnal variations, in consequence of which a field observation is unlikely to give the mean value for the day. Supposing, for simplicity, we had a magnetic observatory at the centre of an area, throughout which the secular and diurnal changes were each invariable. Then to deduce from a field observation the value of a magnetic element at a particular epoch, we should simply apply to the result of the field observation a correction, based on measurement of the observatory magnetograms, representing the difference between the values of the element at the observatory at the time of the field observation and at the fixed epoch. But in the case of a large area the secular and diurnal changes are different in different parts of the area, and a single magnetic observatory is quite inadequate. The survey started with five observatories, Dehra Dun, Barrackpore (near Calcutta), Toungoo (Burma), Kodaikanal in Southern India and Alibag (Bombay). Barrackpore was given up in 1915, leaving only four observatories, including Alibag, which is under the Meteorological Service. Even in a compact country shaped like a parallelogram, four observatories situated at the corners could not supply all the information desirable as to secular change, unless its law of variation throughout the area were very simple, and it was found necessary to supplement the observatories by 80 "repeat stations" scattered over the country. By repeating observations at these stations after 5-year intervals, a great mass of information was obtained as to the secular change. Including the repeat stations there were in all 1,481 field stations in India, Burma and Ceylon, including 4 in the Andaman Islands. The elements observed in the field were the declination (D),

the horizontal intensity (H) and the dip or inclination (I). In a general way the regular daily range in D varies inversely as H. In India, H is very high, and the daily range of D correspondingly small. Again, near the equator magnetic storms chiefly affect H. Further, while secular change of D is much larger in the south than in the north-west of India—the mean annual change from 1909 to 1915 being about 6½′ to the west in Ceylon, whilst at Quetta it was practically nil—the change at all the observatories followed a very regular course, as is clear on inspection of the diagrams IA, IB, and IC. Thus D was a comparatively simple element to deal with. The results are embodied in maps 4 and 5. These show as black lines the isogonals (lines of equal D) for 1909.0 and 1920.0, and as coloured lines the lines of equal rate of secular change for the three periods 1902 to 1909, 1909 to 1915 and 1915 to 1920. In 1920 the line of zero declination ran across India in a generally E.N.E. direction, passing a little to the north both of Bombay and of Calcutta, and at no locally undisturbed place did the compass needle point as much as 4° out of the astronomical meridian. To the north of the agonic line declination is easterly. H was a more difficult element to deal with. As appears from the Kodaikanal figures in earlier volumes of the *Records*, the daily range of H is very large in the south. There is also a great difference as regards secular change between the south and the north. Between 1915 and 1920, H rose on the average about 40 γ (1γ=0.00001 C.G.S.) per annum in Ceylon, while near Quetta it was falling just as rapidly. Again, as is shown in the diagrams 2A, 2B and 2C, the secular change was by no means regular at any of the observatories. The absolute determination of H presents more difficulty than that of D, there being various instrumental sources of uncertainty, which are aggravated when H is as large as in India. In view of the rather numerous instrumental changes disclosed in Tables II to VI of Part I, it is by no means improbable that the apparent secular change irregularities are partly of instrumental origin, but some of the principal ones seem to represent the remarkable tendency in H to suffer a large depression after violent magnetic storms, which may take weeks or even months to disappear. Maps Nos. 6 and 7 deal with H for the same epochs as the D maps. Some 300 miles south of Rangoon, H reaches the value of 40,000γ, which is attained in only a very small area on the earth's surface.

Maps 8 and 9 give the isoclinals (lines of equal dip) for 1909.0 and 1920.0, and the corresponding lines of equal annual change. In 1920 the magnetic equator (i.e., the locus where the dip vanishes) crossed the northern part of Ceylon from east to west. In the south of Ceylon the south pole dipped 5°, while near Peshawar the north pole dipped 50°. Thus the range of dip in India is very large. The north pole is going down (or the south pole rising) rather rapidly all over India. In the neighbourhood of Quetta, the annual change between 1909 and 1915 reached 9′. Maps 10 and 11 relate to a derived element, the total force, for the two epochs 1909.0 and 1920.0.

Full particulars of the values of the elements at all the field stations appear in the tables on pp. 1 to 92 of Part II, and on pp. 103 to 116 the geographical surroundings of the 80 "repeat stations" are described.

The volume gives in a concise form the results of a very onerous piece

of work on which the Survey Department deserves to be congratulated. The results, while specially useful for magnetic charts, are of general interest to magneticians. One doubt which presents itself is whether a larger number of observatories would not have been desirable. India is often compared as regards area with Europe, omitting Russia. But this European area has over 20 magnetic observatories. We learn from p. 2, Part I, that the original number 5 was decided upon by Sir A. Rücker and the Indian Committee of the Royal Society. But we know that Rücker thought that magnetic disturbance was practically uniform over an area as large as the British Isles, and that when allowance was made for differences of local time, the same was true of the regular diurnal changes. This is far from true, and with the knowledge now possessed Rücker would probably have desired a considerably larger number of observatories. The ultimate determining factor of course is the money available, but with a view to future possibilities it may not be amiss to point out the very big gap in the north-west. Observatories in Ceylon and in the north-east also suggest themselves, and if importance attaches to the east coast of the Bay of Bengal, an observatory there about 10°N. would probably be useful. At the present moment, owing presumably to financial stringency, only two magnetic observatories, Alibag and Dehra Dun, are in action in the whole of India. This seems very inadequate even for purely survey purposes, and from a wider scientific standpoint it is simply lamentable.

CHARLES CHREE.

EXCAVATIONS ON THE HILL OF OPHEL* AT JERUSALEM.

To the south of the Haram enclosure, in Jerusalem, there runs a desolate looking spur some six hundred yards long, a spur covered with cabbage gardens, with a few mean houses on it, and here and there some traces of excavation. This spur is, without doubt, the site of the original hill-top fortress which David captured from the Jebusites about the year 1000 B.C. It is the City of David. It is Mount Zion, the Joy of the whole Earth.

There is no site more rich in associations with the origins of our civilization than this miserable-looking hill; there is no site which more deserves to be excavated and explored; there is no site which brings us more definitely into touch with early written history. But it is only in comparatively recent years that it has been recognized for what it is.

In the year 1867, the Committee of the Palestine Exploration Fund obtained permission from the War Office to engage the services of Lieutenant C. Warren, R.E.,† to undertake exploration and excavation in Jerusalem, and in February of that year, Lieut. Warren and a party of Royal Engineers arrived in Palestine and commenced work, which was continued for more than three years.

* *Palestine Exploration Fund Annual*, 1923-1925. *Excavations on the Hill of Ophel, Jerusalem.* Published by order of the Committee, 2 Hinde Street, W.1. Quarto 216 pp. plus viii, with XXVI plates and 217 illustrations in the Text, 2 maps and an Air-Photograph. Price 40s.

† "Et ille quidem plenus annis obiit, plenus honoribus." (Ed., R.E.J.)

The history of past excavations is briefly as follows: Lieut. Warren discovered, deep down in the rubbish of centuries, the remains of a great wall, on the eastern side of the Ophel Hill, towards the north, and he followed this wall for 700 feet. He named it justly, the Wall of Ophel. It has been shown in recent years by Father H. Vincent, to rest upon a Jebusite foundation; and there are analogies in its construction with the methods used in the construction of the walls of Troy, walls built sometime about 2000 B.C. But, from an historical point of view, Lieut. Warren's most interesting discovery was that of the great shaft and associated passages leading from the crest of Ophel to the Virgin's Spring in the Valley of the Kedron. Most scholars are of opinion that this is the veritable *Gutter* up which Joab climbed when David captured the city.

It is written that David said, "Whosoever smiteth the Jebusites first shall be chief and captain." And Joab the son of Zeruiah went up first and was made chief. And, in another account, we read that David took the stronghold of Zion, the same is the City of David. And David said on that day, "Whosoever smiteth the Jebusites let him get up the gutter (or watercourse)."

Of equal interest is the tunnel cut by King Hezekiah's orders through the rock, from the Virgin's Spring, which is Gihon, to the interior of the then existing bounds of the City at its Southern extremity, the Pool of Siloam. About the year 701 B.C., Jerusalem was threatened by Sennacherib; and Hezekiah took council with his princes and his mighty men to stop the waters of the fountains which were without the city, and they stopped all the fountains and the brook that flowed through the midst of the land, saying, "Why should the Kings of Assyria come and find much water." The tunnel then made by Hezekiah is some 600 yards long, cut through the limestone rock. Lieut. Warren and his party mapped the course of this tunnel in very difficult circumstances, the water being sometimes up to their necks. In 1873, Lieut. Conder again mapped the tunnel; and in 1909-11, the water in the tunnel having been diverted by the Parker Mission, Father H. Vincent made fresh surveys of the tunnel and of the other subterranean workings, some of these being pre-historic and, of course, long anterior to the time of Hezekiah. It was just inside the western end of this tunnel that there was found the celebrated Siloam inscription describing the meeting of the two parties of tunnellers who had worked towards each other from each end.

Then we have excavations in 1894-97 by Messrs. Bliss and Dickie, who discovered the remains of a Byzantine Church to the north of the Pool of Siloam, and also a paved street leading down the Tyropœon Valley to the West of Ophel. And the Parker Mission in 1909-11 enabled Father Vincent to find some prehistoric burial caves and a remarkable megalithic gateway near the crest of the Hill.

In 1913-14, and again in 1923-24, Mr. Raymond Weill, on behalf of Baron E. de Rothschild, carried out excavations at the southern end of the ancient city and discovered certain passage graves and a great isolated round tower, well outside the walls of the City to the east, and more interesting still, the remains of the Jebusite fortifications at the southern end of the Spur, so that we know the southern limit of the fortress.

So, after this long introduction, we come at length to the subject of the book under review, namely, the excavations carried out in 1923-25, for the Palestine Exploration Fund, by Professor R. A. S. Macalister and the Rev. J. Garrow Duncan. An account of these excavations is given in an admirably produced quarto volume of over 200 pages, very fully illustrated and accompanied by two maps and an air-photograph. The work was undertaken at the suggestion of Professor Garstang, then Director of the Department of Antiquities under the Government of Palestine; the chief stipulation being that £5,000 should be spent on it. Of this sum, £2,000 was given by Sir Charles Marston; £1,000 by the *Daily Telegraph*; and £1,000 was voted by the British Academy, from the funds of the Schweich Bequest; the balance being paid by the Palestine Exploration Fund.

The work was confined to excavation in three fields, generally on the eastern side of the spur, and some 100 yards to 200 yards to the south of the present city wall of Jerusalem. A study of this book will show what a very skilled matter excavation is, or should be, nowadays. Professor Macalister clearly describes the various strata of excavation, beginning from the rock surface upwards. We find first of all, then, the rock surface with entrances to caves and an early trench, the depth of the rock surface varying from about 7 feet to 30 feet below the present surface. On the rock surface were found those mysterious, but not uncommon, evidences of primitive religion, cup-marks. Then, next above this, we find the Jebusite stratum; on the eastern edge there are some fine portions of Jebusite walls and inclined ramps, no doubt portions of the very fortifications from the top of which the Jebusites taunted David.

We then come to the Hebrew stratum, and above that to the Herodian, Roman and Arab strata. Perhaps the finest discovery of all was a stretch of the early Hebrew fortification which may be attributed to the time of David and Solomon. This fine piece of wall, called the Great Tower on the map, is a projecting flanking tower, 57 feet long and some 18 feet in the return. What its original height was, no one can tell; but about 25 feet is now visible, or was visible during the course of the excavations. "The masonry and dressing is similar to the masonry found at Megiddo and Gezer, which has been assigned to Solomon by Schumacher and Macalister respectively." They regarded the masonry of this class found on these sites as part of the repairs carried out by Solomon in accordance with the notice given in I Kings. . . . . "It is inferred that the upper part shews the repairs carried out by Solomon on the walls of the City of David." The masonry of the top eight courses differs from that below, in which the stones are not dressed and the face is plastered. The masonry of the lower portion is assigned to David, and the assigned date is confirmed by pottery found in the face of the wall.

As to the smaller finds, pottery of Neolithic, Early Bronze, Third Bronze age, Hebrew and Meccabæan dates are recorded; the trench in the northern field "was filled with earth containing countless sherds of the Middle Bronze Age (2,000-1,600 B.C.)." One ostrakon (inscribed sherd), was found, the writing on which is ascribed by experts to the seventh century B.C. "It merely tells us of the existence of three persons of whom we never heard before, of whom we even yet know nothing, and

of whom we are not likely now to hear again. Thus does antiquity mock those who would pry too curiously into her secrets." There was also found a large number of the handles of Rhodian and other wine jars, inscribed in Greek.

But, in the main, these excavations, spread over more than half a century, have revealed to us the character of the Jebusite hill-top fortress; the outline of its walls on the east and south, the nature of its masonry and of that built in the reigns of David and Solomon. We have discovered primitive and complicated subterranean passages stretching back to a very distant past. We know that the Jebusites had a water-passage similar to that of Gezer. We know that the southern point of the fortress was, in Jebusite times, defended by a keep inside the wall of the fortress. We know all the details of Hezekiah's great engineering work, the tunnel, which was to prevent Sennacherib from finding and using the water of that ancient and sacred, serpent spring, Gihon—the spring which was, doubtless, the cause of the original settlement. And we know how the early Hebrew kings shut in the water of the Pool of Siloam, and how the later kings built a buttressed wall across that valley.

These and other things we know; but there is much, also, that we do not know. We do not know where David and his successors were buried, though it was probably somewhere on this small spur. We do not know the site of the Akra, and are doubtful about the mysterious "Millo." We have not yet traced the remains of the fortifications on the western side of the ancient city, though, as these were inside the walls of the later city, there may be but little left of them. We do not know the northern limit of the Jebusite fortress. There is, in fact, a great deal to be done before we can say that this wonderful site has yielded up all its secrets. Perhaps, one day, the Palestine Exploration Fund will again dig on Ophel. All who are interested in the present remarkable movement, for reconstructing and revivifying history by means of the discoveries of archæology, will hope so.

C. F. CLOSE.

SCOUTING ON TWO CONTINENTS.

By MAJOR F. R. BURNHAM, D.S.O., Chief of Scouts under Lord Roberts. Edited and arranged by Mary Nixon Everett. (William Heinemann Ltd., 1926). Price 15s.

This is a volume of reminiscences, to be followed, it is to be hoped, by others, of the famous American scout of whom Rider Haggard has said:—"Burnham in real life is more interesting than any of my heroes of romance."

Born and bred among the early pioneers of the Middle West and California, he grew up among the cow-punchers, gunmen and old time prospectors of Arizona. It was on the Mexican border fighting the Apache Indians that he learnt what scouting means.

Attracted to Africa, like many another American, by the reputation of Cecil Rhodes and the lure of the mineral resources of South Africa, he made his way with his wife and child to Durban. A long and dangerous trek with a donkey-wagon brought them to Victoria in Mashonaland.

There meeting Dr. Jameson, he soon found himself enlisted in the Chartered Company's forces for service against the Matabeles. He served throughout the first Matabele War (1893), and his account of that expedition is a valuable addition to the little that there is in print on the subject. His description of the last stand and death of Major Wilson and his gallant patrol is more than thrilling. After the death of Lobengula in January, 1894, Burnham organised a prospecting expedition to the Zambesi, and then, in 1895, decided to pay a visit to his Californian home by way of Egypt and Europe. In Paris in January, 1896, he heard of the Jameson Raid and at once abandoned his visit and returned to South Africa in time to take part under General Baden Powell and Colonel Plumer in the Second Matabele War (1896)—an aftermath of the Raid. It was Burnham who, with Mr. Armstrong, located the notorious witch-doctor, the M'Limo, the instigator of the rebellion, shot him in his cave and so ended the war.

Burnham then returned to America and joined in the gold rush to Klondike. In Alaska he heard of the outbreak of the South African War, and in December, 1899, received a cable appointing him Chief of Scouts on the staff of Lord Roberts. He reached the Orange Free State in time for Paardeberg and the advance to Bloemfontein. In the disaster at Sanna's Post, he was taken prisoner by the Boers. The story of his escape from the prisoners of war convoy is as good as anything in "The Escaping Club." His next exploit was in company with an officer of Royal Engineers, Major A. G. Hunter-Weston, and a small party of Sappers who were sent to cut the railway line north of Kroonstadt behind the retreating Boers. It was during this raid that Sergeant Kirby, R.E., won the Victoria Cross. Later, Burnham carried out a similar raid between Johannesburg and Pretoria, but, in an unsuccessful attempt to blow up the line leading eastwards from Pretoria, he had his horse killed and was himself badly wounded near Irene. He returned to England, and was awarded the D.S.O., and given an honorary commission as Major in the British Army.

The book is a thrilling narrative of adventure, and is full of value to the young officer for what it has to say of scouting and scoutcraft in a series of "small wars." His criticisms on the conduct of operations are outspoken, but to the point. His appreciation of the characters of Cecil Rhodes, Paul Kruger, Jameson, Lord Roberts and many others whose names are linked with the development of South Africa are interesting, and his judgment on the aspirations and characteristics, good and bad, of the Boers is a kindly one.

He tells a good story against the British officer: "Some of the peculiar instructions occasionally given to junior officers by their superiors before sending them on patrol were brought sharply to my notice one night. When there was no longer even a dim glow from the sunset and the stars began to shine brightly, the C.O. of the cavalry patrol I was guiding asked me what I was bearing on to find the station at Irene. I pointed to a star not far from the western horizon. He said "Ah, yes! That's right. Always use a star." We rode on, winding in and out and changing our course very often. After about two hours, the C.O. rode forward and said to me: "Burnham, I have been noticing for some time that you are

not accurately bearing on the star you pointed out to me. Are you quite confident of your direction ?" It took a little time to convince him that his instructions to use a star as bearing, if followed out literally, would soon reverse his direction. But however faulty his astronomy, there was nothing lacking in his courage to attack the Boers, or to do his best to cover my movements when in contact with them."

Which reminds the reviewer of another star story in South Africa. A British Officer was taken prisoner by the Boers near the railway line running north and south, north of Kroonstadt, and was carried off by them in an easterly direction. At a point which he estimated was forty miles east of the line, he managed to escape, and after several days, moving by night and hiding by day, he stumbled up against the outposts of a British force occupying the town of Lindley. He had lived on mealies and Kaffir beer and was in an exhausted condition. When he had recovered sufficiently he was interrogated by the I.O. as to his movements since his capture. He explained that when he escaped from the convoy, he made up his mind to make his way back to the railway, which he estimated to be about 40 miles to the westward. Recognising the "Southern Cross," he therefore decided to march on the westernmost star of that constellation, and did so for about 30 miles when suddenly he was challenged by a British sentry. Discovering he was at Lindley, he asked if he was on the railway. He was told that Lindley was 50 miles east of the railway. He could not understand it. I doubt whether, if he is alive, he has yet realized why he was misled by the star. Lindley is about 30 miles due south of where he escaped.

In his account of the first Matabele War, Major Burnham several times mentions a native Fingoe scout, by name John Grootbaum—" the coolest and bravest black (he was black, not brown) of all my African experience." It may interest him to know, if he ever sees these lines, that John Grootbaum served as a scout with Plumer's Column from 1899 to 1902, and was killed by a Boer after the war for having helped the British. He was not only a brave and reliable scout, but invaluable in discovering and reporting at once if a strange native joined the column—no small matter when there were two or three hundred natives, drivers and others, with it. On one occasion he was following up the Boers in the Pietersburg (Transvaal) district when one of their wagons stuck in a drift. The Boers rounded up the natives in the kraal where J.G. was hiding and employed them to unload the wagon, which happened to be carrying the ammunition of the last "Long Tom" in the possession of the enemy. J.G. helped to unload and counted the number of rounds. Returning to his column he guided a patrol to the spot and followed up the spoor. Eventually the remains of the gun were found in a kloof, it having been blown up by the Boers in their retreat.

Soon after this he was sent from the Pietersburg line across country to the Middleburg line, a distance of over two hundred miles, to pick up any information he could of wandering Boer commandos and report it to the first British post he came to—and ask to be sent back to his column. He made his way on foot and unarmed, and duly reported, but the I.O. to whom he gave his information committed an unforgivable crime. Realising his value he used him scouting for his own purposes and refused to

send him back by rail. Eventually J.G. returned on his own. He deserved a better end.

"Scouting on Two Continents" is better reading than a novel, and no officer can fail to benefit by Major Burnham's experiences in scouting, tracking, and horse-mastership, to say nothing of man-mastership and knowledge of the native mind.

The book lacks an index and a general map of the date at which the events that are recorded took place. It is to be hoped that in the promised second volume these deficiencies will be made good. There appears to be an error on page 331, where the Lieutenant Childs mentioned is stated to belong to the R.E.

H.B-W.

"THE DIVINING ROD."—AN EXPERIMENTAL AND PSYCHOLOGICAL INVESTIGATION.

By (the late) SIR WILLIAM BARRETT, F.R.S., and THEODORE BESTERMAN. (Methuen & Co., Ltd., 1926). Price 18s.

The book is written "with the object of investigating by means of historical researches, by the collection and collation of large numbers of contemporary cases, by the carrying out of experiments, and by a discussion of the results thus obtained, the claims made on behalf of "water-divining," or "dowsing." "

It contains a mass of indisputable evidence, proving that it is possible to find water, oil, metallic ores, coal and hidden objects by means of the divining-rod.

It is practically certain that the birthplace of the modern use of the divining rod is in the mining districts of the Harz Mountains in Germany. Dowsing was probably introduced into England in the latter half of the sixteenth century by German miners brought over to work in the Cornish mines. The origin of the words "dowsing" and "dowser" are unknown. The "rod" used by the dowser is generally of green wood, and generally, but not always, V-shaped, but may also be of metal or even galvanized wire. There have been dowsers who worked with their hands alone. The V-shaped twigs used by the celebrated John Mullins (1838-1894), were of pliable green wood about 15 inches in length, three-sixteenths of an inch in diameter at the points of the V, and about a quarter of an inch in diameter close to the junction. The wood generally employed is white-thorn, but the black-thorn, hazel, plum, apple, willow and bamboo are also used. The methods of holding the rod, and its action, are clearly illustrated by diagrams in the book.

Attention has recently been drawn to the subject by the appointment of an official dowser, an ex-officer, by the Municipality of Bombay, and it will be remembered that dowsing was successfully employed for finding water on the French Front during the Great War. Two authenticated instances in which a good supply of water was found by R.E. Water Supply units near Albert with the assistance of an amateur dowser, Colonel Hugh Rose, are described with full details on pp. 194-196, of the book; and amongst the numerous other examples mentioned there is a

case in Derbyshire which is personally vouched for by the late Major-General R. H. Jelf, R.E. The authors have gone to great pains to obtain and record reliable evidence in each case investigated and in many of them plans of the locality are provided to illustrate the letterpress. The authors do not hesitate to give examples of cases in which the dowser has failed, or has not achieved complete success.

Dowsers are born, not made; and experienced dowsers are by no means numerous, partly because the gift is confined to a few, and partly because of lack of opportunity to test by digging the powers they may be known to possess with the divining-rod. An experienced dowser is able to estimate roughly the quantity of water available, as well as indicating the line and estimating its depth below the surface. Dowsers are not infallible, but the proportion of successes is far larger than is generally supposed. John Mullins is said to have been successful in nine cases out of ten. The record during twelve months in India of the official dowser recently appointed by Bombay is reported to be even better. It was by mere chance that John Mullins was discovered. In 1859, a water line had been indicated by the professional dowser Adams in a locality where Mullins worked as a stone-mason. The owner of the property having seen the professional at work thought he might discover a local man who possessed the gift; he got his employees to try what they could do with the divining rod. In Mullins' hands the twig reacted the moment he approached the line indicated by Adams, of the direction of which Mullins was unaware. A well was sunk and water found. Thereafter Mullins was frequently employed to find water, and eventually he set up as a professional dowser and well sinker. His two sons inherited the faculty, but were not so successful as the father. Accounts of the work of these men, and of about thirty other dowsers, professional and amateur, and of both sexes, are given and are supported by a mass of evidence.

John Mullins was a man of good reputation, and as a dowser was found to be thoroughly honest and trustworthy. Unfortunately, this has not always been the case with others of his profession, and consequently the dowser has come to be looked upon with suspicion by scientific men, and especially by geologists.

The authors, after reviewing the evidence which they have collected, come to the following conclusion:—"It is unnecessary to employ a dowser in districts the geological formation of which is known to fall under either of two heads. On the one hand, if the district is over porous or permeable rocks, water may readily be found almost anywhere. On the other hand, if the locality is over non-water-bearing rocks, water can, as a general rule, be found only where the impermeable or impervious rocks have been pierced. In the former case, the experienced well sinker can do the work; and in the latter, recourse must be had to a geologist, or, by preference, to an hydro-geologist. A large field is left to the dowser, in the numerous regions in which the non-water-bearing rocks have faults, fissures, joints, and the like, or are in a decomposed or shattered condition. We can, therefore, understand the reason why so many dowsers originate from Somerset; it is because this region is among the most typical examples of the condition just described. It is in such regions that the dowser should be employed, and it is under such conditions that he has scored some of his

most striking successes.....Even where deep wells are necessary, experience has shown that it is sometimes advantageous to supplement geological advice by calling in a dowser, for though a definite water level may exist, the *quantity* found at a given spot is often a matter of chance."

The authors devote a chapter to the rationale of dowsing. The conclusion to which they believe an impartial student of the facts set out in their book must come, is as follows :—" The dowser, in our opinion, is a person endowed with a subconscious, supernormal cognitive faculty, which, its nature being unknown, we call, after Professor Richet, cryptesthesia. By means of this cryptesthesia, knowledge of whatever object is searched for enters the dowser's subconsciousness and is revealed by means of an unconscious muscular reaction, or, less often, by an obscure nervous sensation or emotion which produces physiological disturbances : or, very rarely, by means of direct supernormal cognition made conscious by a visualisation or hallucination. We do not believe that the accumulation of further masses of evidence, though of course this is not undesirable, will make the argument for these contentions any stronger. All that is required is the discovery of some fruitful generalisation which will permit the orthodox scientist to incorporate cryptesthesia in the canon of accepted and indisputable scientific knowledge."

The reviewer has recently had personal experience of a most successful example of the dowser's art. The dowser, a professional, located two underground water lines, one at about 22 feet and the other at about 100 ; the two lines crossed each other, and the dowser selected a spot in the deeper line, as there was reason to suspect the purity of the upper water layer. A boring was made near the point which was close to where the two lines crossed, and at a depth of 95 feet a supply of excellent water, giving 400 gallons per hour, was successfully tapped. The remarkable thing was that the dowser was in no way affected by the proximity of the two lines of water, and was able to peg out the direction of both lines of water accurately, and to estimate their strength. This was a case in which the geological conditions were complicated by the known existence of two deep parallel faults 300 yards apart, between which several deep borings, up to 200 feet, had been made in the vicinity some years ago without finding water. The new boring is through two feet of top soil, 87 feet of Sussex clay, and six feet of sandstone rock. The water flows on the top of another bed of clay below the sandstone. The upper stream of water located by the dowser at a depth of 22 feet has been traced to its outlet in a line of small springs on the hillside 150 yards from where it was located. Analysis proves it to be unfit for drinking.

It is worth while recording that modern water engineers decline to work on the " no water, no pay " terms of the old dowsers, such as John Mullins, who were prepared to dig the well themselves, if the dowser's fee was slightly increased, and be paid at a fixed rate per foot if a reasonable supply was obtained. The new boring referred to cost, as per estimate, £285, inclusive of the dowser's remuneration and expenses, and the installation of a wheel pump worked by hand and delivering into a tank 30 feet above the ground level.

The conclusion to which the military reader of this interesting but rather ' heavy ' work must come is, that an experienced dowser should

be available at headquarters of any force in the field to assist the engineer officers responsible for water supply. The want of such an expert was severely felt in the South African war. Many lives would have been saved and much fruitless labour avoided if an experienced dowser had been available, for instance, during the long halt at Modder River. Amateur dowsers did their best, but the results were almost nil. Geological data can generally be obtained of a possible theatre of war, but a dowser with experience of local conditions is a *rara avis*.

The book is amply illustrated, and includes a very large bibliography and a complete index, and should find a place in every engineer library.

H.B-W.

K.A.R.

By MAJOR W. LLOYD-JONES, D.S.O. (Arrowsmith, 1926). Price 18s.

Major Lloyd-Jones has earned the gratitude of all who, at one time or another, have served either in, or with, the King's African Rifles, for his attractive unofficial account of the origin and activities of that, perhaps, too little-known Colonial force. This, young though it is in years, has already made history in British East African territories. But the book is of interest not only to its past and present officers, for it contains much sound advice to those who may desire to join that adventurous Corps in the future. It supplies, moreover, a fund of information to those who wish to learn something of the gradual development of our great East African possessions during the past forty years; since the activities of the K.A.R. cover a wide area, embracing Nyasaland, Tanganyika Territory (during and subsequent to the Great War), Kenya, Uganda, and British Somaliland; in all of which once remote regions, operations have been carried out, and those countries now protected, by units of the King's African Rifles.

It is, indeed, a fine record that the author marshals in orderly array before the reader. The ground he traverses is extensive, for he describes the diverse nature of the theatres in which the mobile K.A.R. have been called upon to operate, including the long drawn-out strain on native personnel while building up numerous fresh battalions for service in German East Africa (now Tanganyika Territory), to confront the elusive, but extremely able, Vorbeck von Lettow. He tells us much, too, concerning the strange medley of Africans that constitute the ingredients of this romantic force, which has won great distinction under the leadership of a mere handful of British officers of junior rank. Imbued with the spirit of adventure, while sympathetic towards those they are training, many of these young officers have quickly gained the complete confidence, and even affection, of natives who were but untamed savages a short while ago; and the dog-like devotion of these Africans, when properly treated, to their British officers, is strongly brought out by the author, who, one can judge, rigidly practised what he preaches concerning this important matter.

Within the limits assigned, it is only possible to refer but briefly to the contents of this interesting book. Nevertheless, the reviewer endorses

fully all that his old friend of Uganda days, Major-General Sir Cecil Pereira, K.C.B., says in his Foreword, namely, that changes in East Africa have been so great and development so rapid that it is fortunate Major Lloyd-Jones formed the idea of writing the history of the K.A.R. now; for the longer such a work awaited an author the more meagre would be the results, since records of expeditions were necessarily scanty where pens, ink and paper were scarce, while many called upon to make reports were not much given to their use.

Major Lloyd-Jones has proved himself an ideal author for the task, obviously a labour of love on his part; for, like many who have drunk deep of the waters of East African life and travel, it is clear that his heart is still in the country where he so much distinguished himself. The book is admirably illustrated with 43 photographs and a map, which increase the interest of the letterpress; while a carefully compiled index at the end adds to the value of this attractively got-up and well-written record of stirring events.

H.H.A.

THE DAYS OF MY LIFE.

An autobiography, by SIR H. RIDER HAGGARD. Edited by C. J. Longman. 2 vols. (Longmans, Green and Co., Ltd., 1926). Price 28s.

A book to be read by all who are interested in the history of South Africa. Sir H. Rider Haggard was private secretary to Sir Theophilus Shepstone, when the Transvaal was annexed in 1877, and he throws a good deal of new light on the reasons which influenced Shepstone in deciding on the annexation, and carrying it out on his own responsibility. He was convinced that if he did not intervene and plant the British Flag at Pretoria, the Zulus, whose impis were all ready on the border, would sweep the Boers out of the Transvaal. By bringing the republic under the aegis of Great Britain, Shepstone was able, thanks to his personal influence with Cetewayo, to induce the Zulus to withdraw. It was a marvellous piece of bluff on the part of Shepstone and the handful of Englishmen with him. The Home Government approved his action when the annexation was a *fait accompli!*

H.B-W.

"OLD STICK-LEG."

Extracts from the Diaries of Major Thomas Austin, arranged by BRIGADIER GENERAL H. H. AUSTIN, C.B., C.M.G., D.S.O. (Geoffrey Bles). Price 10s. 6d.

Such was the name by which the veteran officer with the wooden leg was called by his great-nephews, who used to meet him tramping along the Whiteladies' Road at Clifton.

Thomas Austin was born on December 18th, 1794, and received his commission in the "35th" or The Sussex Regiment of Foot on May 17th, 1810. From the beginning of his service he appears to have kept a diary which is indeed remarkable for its power of vivid description. He joined

his regiment at Shorncliffe and accompanied it to Guernsey a year later. At that time Napoleon was expected to have designs on the Channel Islands as a suitable point from which to assail England, and the whole coast line was vigilantly guarded by pickets. (On one occasion 'Little Tommy,' as he was affectionately called by his brother officers, captured a boat containing ten French Officers who had escaped from England and had put in to Doyle to get water).

In October, 1813, he went home on leave in the sloop *Chesterfield*, which after a brush with a privateer arrived in safety at Weymouth.

He had only been at home a few days when he heard his regiment had been ordered to Holland as part of the force under Sir Thomas Graham. This British expedition was intended to combine with a Prussian army under Bulow in an attack on Antwerp.

Austin immediately proceeded to join his regiment at Ramsgate, and after some confusion, caused by bad staff work, it eventually embarked at Deal.

The diarist tells us that there was a certain apprehension lest the disastrous mistakes of the Earl of Chatham's expedition of 1809 should be repeated. But he himself was full of keenness, and as an officer of the Light Company was one of the first to land on the Island of Tholen on December 17th, 1813.

He describes in intimate and picturesque detail the conditions which officers and men had to endure throughout the winter campaign, the frightful weather, the poor rations, the lack of fuel and the bad staff work. The bread served out to the troops was made of rye of inferior quality, so coarsely ground that it resembled a conglomeration of sawdust and soot; Schnapps was served out somewhat too liberally; at one time meat was issued in the hoof in the shape of lean cows, and the space of one hour was allowed on the march for killing, cooking and eating this ration.

An advance was made by Sir Thomas Graham towards Antwerp, and after several skirmishes an attack was made on the French at Merxem, a village three-quarters of a mile from Antwerp. During the skirmishing young Austin had the good fortune to save the Duke of Clarence (afterwards King William IV), from capture by the French.

Owing to the failure of the Prussians to co-operate in the attack on Antwerp, Sir Thomas Graham ordered a retreat, much to the surprise and disgust of the troops who had turned the French out of Merxem. Rozendaal was reached on January 16th in a blinding snowstorm.

The advance against Antwerp was renewed early on January 30th in a fearful storm of rain, snow and hail, which turned the ground into slippery sheets of ice. During the advance the Light Company was nearly cut off in a skirmish on Braeschaet Heath, but owing to the resource and courage of the Captain, Alexander Shaw, whom young Austin justly admired, the company was able to hold out until reinforcements arrived.

It was on February 2nd, during an attack on a dyke on the right of the line, after Merxem had been re-captured, that Austin's left leg was shattered below the knee by a cannon ball. He never lost consciousness but encouraged his men to further efforts. After some delay he was carried to the rear attended by his faithful servant, John Hope. Preparations were

made for amputating the limb at Merxem, but that place being found too near the front, he was taken in a wagon to a Chateau at Braeschaet. An operating table was extemporised with bricks in the kitchen, whilst the instruments were laid out ready on the dresser. In these days of anaesthetics, one cannot help taking a morbid interest in the sensations of one who had to undergo an amputation without aid. Austin even refused the profered alchohol, feeling confident that he would not sink. It is consoling to know that he did not find the pain caused by the sawing of the bone and marrow worse than that occasioned by the rest of the operation.

Many gruesome stories are told of the medical arrangements in the army of these days; Austin seems to have been rather fortunate in falling into the hands of two good surgeons so soon after he was wounded.

From the accounts of participants the diarist tells of the siege of Antwerp, and of the disgraceful episode of the assault on Bergen op Zoom. This place, the strongest fortress in Dutch Brabant, was occupied by us after an assault, the success of which seems to have stultified the wits of the officer in command, General Cooke, for after remaining inactive in the place for some hours he allowed his troops to be turned out or captured by a smaller force of French. Sergeant Townsend of the Guards, however, refused to surrender, but with thirteen others cut his way out to freedom. He was many years later made Steward and Porter of Walmer Castle by the Duke of Wellington.

On April 1st, 1814, Austin sailed for home in the *Urania*, which owing to the supineness of the Dutch pilot, was nearly shipwrecked on a sandbank.

In July, he joined the Depot at Chichester, but retired after the battle of Waterloo, realising that his active military career was over.

In a commission dated July 27th, 1820, he was made Fort Major of the Fort of Duncannon in the County of Wexford, apparently as a reward for his war services and for saving the Duke of Clarence.

He spent 50 years at Duncannon, engaged mostly in literature, sport and geological excursions, and then settled at Bristol, where he died on March 25th, 1881.

This is a most entertaining book, presenting a vivid picture of life on active service in Napoleonic times, and unconsciously revealing the character of one who was a brave soldier and a humane and cultured gentleman.

A.H.B.

MAGAZINES.

REVUE MILITAIRE FRANCAISE.

(*July*, 1926.)—Commandant Desmazes concludes his excellent series of articles entitled *Les débarquements Alliés aux Dardanelles* in this number. The evacuation is passed over rather too rapidly; one would expect some indication of the elaborate preparations required, but the writer's conclu-

sions on the whole series of operations are of considerable interest. While realising the magnitude of the failure and setting forth clearly most of the contributory causes, he considers that the Turkish Army was so shattered by the severity of the fighting that the foundation of our eventual successes in the Near East is to be found in the Dardanelles operations.

In concluding *La Guerre Chimique*, Chef d'escadron Paul Bloch describes all the chemical materials which go to make munitions of war, and points out the great superiority of the German chemical industry at the outset of the Great War. If it had not been for the German chemists and this industry, Germany could never have held out so long, quite apart from the invention of gas as a weapon. The writer points out the efforts made by the French to set their chemical industry on a more secure footing, but is of the opinion that a great deal more work requires to be done in the interests of security.

Commandant "T" concludes his article *L'armée Anglaise et ses grandes manœuvres de* 1925 with a brief but clear description of the actual operations, and a reasoned criticism of the results obtained. The outstanding feature appears to the writer to be the immutability of the principles of war, whatever the changes in armament. The chief lessons drawn are the continual need for reconnaissance, the difficulties of co-operation between arms moving at different speeds, and the necessity for definite regulations on the use of mechanical forces. The air operations are well commented on. It is comforting to find that the writer considers that, in spite of the mistakes made, our army "is more than ever capable of intervening, with decisive results, in a war of some duration on the continent."

The operations are well illustrated by sketch maps.

Le Cinéma dans L'armée, by "X," emphasizes the value of training by eye rather than by ear, especially for a short service army. The procedure of preparation and instruction is well outlined, and a list of military films appended.

In *Notes sur la Conduite d'une Brigade mixte au Maroc septentrional*, Colonel Duffour, who has been for some time a brigade commander in Northern Morocco, discusses the composition of mixed brigades and the methods to be employed in operations in this part of Africa. The special application of the principles, laid down in the regulations, to mountain warfare is clearly brought out in these notes. As usual, co-operation between the various arms offers great difficulties, and it is interesting to note that the infantry of Colonel Duffour's Brigade were trained to attack any area which received an artillery bombardment, the duration of such bombardments and the subsequent lengthening of range being agreed upon beforehand when circumstances prevented close liaison between the two arms.

Une Opération au Levant; l'affaire de Medjel-el-Chems, by "X," is a short description of an action against the Druses near Mount Hermon. The capture of the village of Medjel-el-Chems produced important political results; but with the somewhat meagre sketch map supplied it is difficult for anyone unacquainted with the country to visualise the operations clearly.

(*August*, 1926.)—Commandant Janet's *Action d' une Division encadrée dans une offensive d'ensemble* describes the advance of the 48th

Division of General Mangin's Tenth Army at the end of August, 1918. The general procedure of the operations of a centre division taking part in a big offensive is familiar to most officers who served in France towards the end of the Great War. The chief interest in this instalment is the method by which the enemy's forward zone was driven in by the French covering troops on the days preceding the main attack on August 20th, which was delivered by fresh formations which came into line during these preliminary operations. The article is illustrated by a somewhat inadequate sketch map, and ends with the close of the first day of the main attack.

The first instalment of Lieutenant-Colonel Paquet's *Formations des Officiers de renseignement. Organisation d'un stage au corps d'armée*, appears in this number. The writer gives a detailed and valuable description of the practical side of a course for Intelligence Officers organized by the Fourteenth Army Corps, and begins a detailed account of an actual paper scheme carried out during the course. Staff and regimental (including Air Force) officers take part in the course, the greater part of which consists of exercises without troops and controlled with great care by the officers of the Directing Staff, who criticise the exercises by stages as they develop.

General Rouquerol, in *La prise du fort de Douaumont*, begins a description of the operations of the 7th and 8th companies of the 24th Brandenberg Regiment, from the narrative of Lieutenant von Brandis, who commanded the latter company. The article combines a severe criticism of the Prussian officer's boastfulness and bias, with an outline of the contents of his narrative; as a result, the actual operations are difficult to follow clearly. What does stand out, however, is the overpowering effect of the German bombardment compared with the inefficacy of the French artillery; apparently the heroes of Douaumont (as the two company commanders have been acclaimed) remained in almost continuous touch by telephone with battalion headquarters, while the French communications were almost entirely destroyed.

In *Le problème du char de combat en* 1926, Lieutenant Colonel Pigeaud deals mainly with the capabilities of the existing "Renault" tank. Referring first to a previous series of articles in the *Revue*, the writer expresses the opinion that light, battle and super-heavy tanks will be required in future, with armaments ranging from the machine gun to the 6-inch gun. Turning to the "Renault," he discusses in considerable detail its employment in the various operations of war. The weak point of the contention that this type of machine is still generally satisfactory appears to lie in the necessity for lorry transport for a proportion of the tanks of each regiment. One can only wonder what would be the result of putting "Renault" tanks on 7-ton lorries in time of war.

Lieutenant-Colonel de Nerciat's article, entitled *A propos du cinquantenaire de L'Ecole supérieure de guerre*, reviews briefly the ceremony of the 50th anniversary of that famous institution, and draws attention to the success attained by some of its greatest professors and pupils.

(*September*, 1926.)—The second instalment of Commandant Janet's *Action d'une division encadrée dans une offensive d'ensemble* describes the exploitation by the 48th Division of its success on August 20th. By the

evening of August 22nd, thanks largely to a brilliant operation carried out by a battalion of the 13th Tirailleurs, the division had advanced several miles up to the Oise-Aisne Canal. It is difficult to study the operations closely, although they are clearly described in considerable detail, owing to the inadequacy of the two sketch maps provided.

Lieutent-Colonel Paquet completes his article *Formation des Officiers de Renseignements. Organisation d'un stage au corps d'armée* in this number. The instalment requires to be read in conjunction with the previous one, as it deals with the development of the intelligence scheme, the earlier stages of which have been previously described. The indications issued by the directing staff to members of syndicates representing regimental intelligence officers, are of particular interest, ranging from captured documents to fragmentary reports of French "listening sets." The article concludes with an excellent guide for the intelligence staffs of the various formations with regard to the preparation of a plan of action, by which the maximum information can be obtained about the enemy's dispositions, both from a general point of view, and as affecting specially the plans of the higher command.

General Rouquerol completes his article *La prise du Fort de Douaumont* with a description of the actual capture and occupation of the fort, still drawn from the writings of Lieutenant von Brandis, commanding the 8th company of the 24th Brandenburg Regiment. According to the German description the operation was a brilliant feat of arms, whereas, in fact, the fort was practically unoccupied by the French; but this does not affect the rapidity with which the German regimental officers seized a heaven-sent opportunity to capture an important tactical locality, while there was little excuse for the French failure to defend it.

L'aviation de bataille chez les Allemands, by Commandant "T," is an outline of the development of aircraft designed to attack the enemy's troops so as to produce decisive results in battle. The German policy is to form a special branch of the air service for these low-flying attacks, but the author has doubts, which will be shared by a good many British officers, as to the value of low-flying attacks as compared with other forms of air action. The article is interesting in showing clearly the trend of German official doctrine on this subject.

Lieutenant Navereau, in *L'ustensile en Argent*, describes an old war-time method of taxation instituted in 1650, by Louis XIV., and discontinued after the Seven Years' War. This tax was levied during the winter on districts which did not have to support troops in winter quarters, and the proceeds were set aside for the payment of the troops, and provision of their equipment for the coming summer's campaign. The tax was very profitable and, on the whole, equitable, in that the burden of the war was spread over as large a population as possible.

REVUE DU GENIE.

(*September*, 1926.)—*Electrification in Stationary Warfare.* A summary of the electrical installation in the 3rd Army Area of the German Army up to 1918. High tension distribution was carried up to within 7 to 10

kilometres of the front on some 400 k.m. of lines, and over 1,000 k.m. at 380-115 volts, with a total installed supply of 8,300 K.V.A. This included a large number of small installations over 200 in number, output some 4,000 K.V.A. These installations provided power for some 700 motors and 80,000 lamps, serving workshops of all sorts and even ice factories and cinemas—not to mention an extensive system of electrified wire entanglements.

Destruction of communications and demolitions (continued). Experience of insufficient damage done on the Russian front taught a lesson that was made good use of in the withdrawal to the Hindenburg line—preparations for which extended over five weeks, and which was described by Ludendorff as a "brilliant exploit." The article describes shortly the general nature of the damage done and the methods used in the French Army for facilitating the advance. A list of bridges built by the French 3rd Army is given. Sketches of various booby traps are included.

The duty of Engineers in the Organization of Positions. Post-war regulations lay down very clearly that the infantry must prepare their own defence works. The duty of the engineers is described as :—

"In the defensive to prepare or improve communications, prepare demolitions—and may share in organization of ground so far as concerns certain special works," and further to carry out "exceptionally and in case of urgency, works that have to be completed in a very short time."

These regulations are the logical outcome of the great changes that have taken place in infantry organization and weapons, and may be justified in theory. But in practice they are untenable. In peace the infantry have no facilities whatever for training in construction of field works, whilst in war they are usually too exhausted by marching and fighting. Moreover, in war every work becomes a special and urgent one.

The prime business of the engineers is to help the infantry to perform their heavy tasks, and the engineers must be trained in peace so as to be be able to do this.

A dangerous post-war tendency has been to label the task of the Sappers as simply "communications." The writer asserts that there are two great tasks, "Communications" and "Fortifications," and that sometimes one and sometimes the other will be preponderant. The writer apparently abandons any idea of revising the peace training of the infantry.

He goes on to discuss the duties of the Engineer Command in relation to organization of ground, pointing out that regulations direct that the Engineer Commander shall take part in the reconnaissance and preparation of plans and orders, and is the immediate assistant to the Force Commander for all technical matters in the orders to be issued. The writer would rather define the duty as "the immediate assistant for everything concerning the organization of positions," on the grounds that tactics and technicalities are inseparable in such matters.

The 5th Public Works Congress. Summary of papers read upon the progress of development of work in harbours, and inland waterways, railways and roads.

(October, 1926)—Demolitions and Repairs of Communications—(continued). In February, 1918, G.Q.G. directed the preparation of a pro-

gramme of inundations and demolitions between Arras and Coucy le Chateau, and approved instructions for wrecking four railway bridges in the British area on March 7th. But the enemy's attack on the 21st March, and their rapid advance, showed that on both the French and British fronts the demolitions effected had been inadequate. On appointment as Commander-in Chief of the Allied forces in France, General Foch issued orders on March 26-27 to the several commanders of groups of Armies directing them to hold their positions, and containing no mention of demolitions. But early in April, arrangements were made for such, and for inundations in the north, and evacuation and wrecking of Dunkirk. When the Germans attacked on the Chemin des Dames, May 27th, no higher command had dreamt of such success, and insufficient detailed programmes had been prepared. In fact, at 4.15 p.m., on 27th, G.Q.G. directed that the bridges must be preserved.

The writer quotes from a report of General Duchêne (commanding VI Army) stating that all preparations for demolition of bridges were ready and checked onMay 26th. The charges for bridges in the British XVII Corps were loaded by 6 a.m., 27th, but the general order to load the charges for bridges was given at about 8.30, which was in many cases too late, and discretion to Corps Commanders to destroy the bridges was given at 10.10 a.m., but the message to the British IX Corps was not sent, communications being interrupted. Some other orders did not reach their destinations.

The failure to destroy so many bridges led G.Q.G. to delegate authority to Armies to carry out demolitions, and on the Marne the XXI Corps Commander delegated the duties to divisions—with successful results—where all bridges were destroyed, and none prematurely. The writer gives in detail two examples indicating, even when every precaution had been taken, the difficulties of deciding on the spot the moment to fire the charge.

Elaborate new orders were issued on July 6th, allotting responsibility to higher or lower commands according to the relative importance of certain categories of works, while in every case the engineers responsible were to receive executive orders from a staff officer.

The writer goes on to quote orders given by Army Groups for the repair of roads during the final advance, and describes in some detail the methods in force in the 31st Division N.E. of Coucy le Chateau, through the St. Gobain Forest, and enumerates the dates at which many bridges were restored.

The writer concludes with an enumeration of the railway demolitions in Belgium and France in 1914.

The 5th National Public Works Congress (continued.)—Summary of papers on waterworks, water supply, drainage, legal matters and mines.

A Protractor for Trisecting Angles. A description.

(*November*, 1926).—*Destruction and Repairs of Communications (continued.)*—Summarises the damages to railway bridges, tunnels and tracks in France, and the dates of repairs by both forces in the first year of the war. Also the repairs to railways in 1917 after the complete destruction in the German retirement. The damages far exceeded expectations—so much so that 10% only of recovered material was usable, even after repair (*to be continued*).

The Adventures of a Pontoon Train in Syria. Describes the painful journey of a train of pontoons by rough roads and inundated country round the Gulf of Alexandretta in 1920.

The Destruction of Structures employing Wire Cables. Describes an ineffective attempt to destroy a suspension bridge by firing gunpowder charges in the centre of the span. The bridge was subsequently quickly and simply broken by lighting fires under the cables.

(*December*, 1926).—*The Supply of Railway Sleepers during the War.* A summary of the organisation for provision, distribution, and cost and qualities provided, together with a description of the system in force before the war.

The Instruction of Engineer Units in the Organisation of Positions. The author finds that the combination of technical instruction with tactical situation presents difficulties; that the supposed presence of an enemy is apt to be ignored, and the necessary working discipline neglected.

He suggests that all detail work by N.C.O.'s should be based upon schemes previously worked out on the ground by the senior ranks under the supervision of Divisional Engineers Staff and accompanied whenever possible by Infantry Officers.

As regards rank and file he suggests that detailed instructions in actual execution of work should be followed by the construction of work under technical conditions and strict service conditions, including night work.

On manœuvres, when ground cannot be broken, useful instruction can be given in organising working parties and issuing tools and intelligent selection of practicable sites for work.

The Siege of Montauban. Extracts from the diary of M. de Pontis, published in 1678, describing various acts of heroism performed by the author.

Destruction and Repair of Communications in the Great War (continued). Sums up the reconstruction of main lines in the areas of the French Armies from July, 1918, till the Armistice.

Points out that on that date rail-head was some 100 k.m. in rear of the troops.

BULLETIN BELGE DES SCIENCES MILITAIRES.

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Les Opérations de l'Armée Belge (1914—1918.) The final phase of the defence of Antwerp is dealt with in Nos. 1 & 2 of the *Bulletin*. Early on the morning of October 9, 1914, the Belgians were still holding Sectors 5 and 6 and the forts in Sectors 1 and 2; directions for the active defence of those parts of the Citadel still held by the Belgian fortress troops were still being issued by Gen. Déguise. But the *morale* of the defenders, it is evident from the narrative, had by this time been reduced to an exceedingly low level. An attempt was made, for instance, to provide against the passage of the Scheldt by the enemy at the "Tête de Flandre," a Belgian fortress battalion being directed to take up a position there. However, the troops were completely out of hand, and could not be induced to put up a fight. Reports reaching Gen. Déguise at Calloo

indicated that the Germans were on the point of crossing the Scheldt; later, it transpired that these reports were entirely false. At a conference held by Gen. Déguise at his H.Q., at 8 a.m. on the 9th, at which the Commandants of Sectors 5 and 6 were present, a very gloomy view of the situation was taken by the subordinate commanders. Nevertheless, Gen. Déguise was reluctant to hand over the Citadel to the Germans until, at least, they had delivered an assault against the defences. But the fact is that the control of the situation had already passed out of his hands, and, in certain cases, subordinate commanders were issuing orders on their own initiative. Later in the day he appears to have realised that the defence had collapsed, and at 18.30 o'c. he directed his Chief of Staff, General Werbrouck, to get into touch with the German H.Q., with a view to opening up negotiations for the surrender of the Belgian Citadel. In consequence, Gen. Werbrouck proceeded to the "Tête de Flandre"—the enemy had been reported to be there—but finding the locality still free from the invaders, he returned to the Belgian H.Q. at 22.30, and reported accordingly. By this time Gen. Déguise was fully convinced of the uselessness of any attempt to prolong the defence of Antwerp, and at 3 o'c. on the morning of the 10th directed Gen. Werbrouck to make another attempt to get into touch with the enemy for the purpose of arranging the terms of surrender. At this time the troops under his command were in full retreat.

At dawn on the 9th, the Germans found that Forts Nos. 4 and 5 had been evacuated by the Belgians, but apparently were still without knowledge of the complete collapse of the defence; however, von Beseler ordered a cessation of the bombardment, and sent a staff officer, Captain von Herringen, with a letter addressed to the "Commander of the Allied Troops" inviting him to surrender the Citadel. About the same time, rumours of the evacuation of Antwerp reached the Civil Authorities in the City; this fact seemed to be confirmed by a report from the police stating that the Fortress H.Q. were unoccupied. Instructions had been given to Gen. Maes to keep in touch with the Civil Authorities in the City, but he does not appear to have done so, and his whereabouts were unknown. The Civil Authorities were now placed in a most difficult position; left to their own resources they held a meeting at the Hotel de Ville and fully discussed the situation. They came to the conclusion that, in the interests of the civil population, their best course would be to get immediately in touch with the H.Q. of the besieging force. A deputation consisting of prominent civil officials accordingly set out between 7 and 8 o'c. on the morning of the 9th, for the German H.Q., then at Thildonck. The deputation being unaccompanied by a military officer, von Beseler was at first unwilling to enter into any negotiations with the members composing it; however, in order to save time, he proceeded at once to Contich and directed the Belgian deputation to wait upon him there at 15 o'c.

On arrival in the City, Captain von Herringen could find no military officer to whom the communication entrusted to him could be delivered, and was therefore unable to fulfil his mission. He proceeded, in consequence, to Contich, where he arrived shortly after his Chief; he confirmed the accuracy of the information as to the evacuation of Antwerp by the Belgian troops, conveyed to the German commander earlier in the day by the Belgian deputation. In these circumstances, von Beseler presented

his terms of surrender to the Belgian deputation when it waited upon him for the second time as arranged; he cut short an attempt which was made by the latter at this second interview to open a discussion on the conditions contained in the document laid before its members for signature. The Belgians, therefore, appended their signatures to the document—containing the German conditions—the text of which is set out in the original article—at 5.40 p.m. (Oct. 9).

Rumours concerning the events mentioned above soon reached the commanders of the forts in Sectors 1 and 2; with a view to preventing these works falling into German hands, they proceeded at once to destroy them as far as possible.

Gen. Werbrouck, on his second attempt to do so, succeeded in getting into touch with the Germans; this occurred at 5.45 on the morning of the 10th. He crossed the Scheldt at about 6.30 a.m. and was taken to the Hotel de Ville, in Antwerp; there he met the Belgian Civil Authorities, and also the Staff Officers representing von Beseler. It came as surprise to him to learn that the German authorities had arranged for the surrender of the Citadel alone with the Civil Authorities; he informed himself of the contents of the document—known as the "Convention de Contich"—executed by the Belgians and the Germans, and, finding nothing in its terms in conflict with the instructions given him by Gen. Déguise, he ratified the terms of surrender on the latter's behalf, and duly reported the fact to his Chief.

It would appear that a misleading impression has been created in Belgium by accounts published concerning the first of the Belgian sorties—Combat d' Impde (Aug. 24)—delivered from Antwerp. Since the date on which the number of the *Bulletin*—i.e., No. 10 (Feb., 1921)—dealing with these operations was published, much additional information on the subject has come to hand; in consequence, a revised account of the operations in question has been prepared and is published in No. 3 of the *Bulletin* under notice.

Le Bataille de Mons. An account of the first collision between the B.E.F. and the German Army in 1914 has been prepared by Major von Egro; it is based largely on the History of the Great War compiled by the Historical Section of the Committee of Imperial Defence. The first two parts of this story are published in Nos. 1 and 3 of the *Bulletin.*

La verité sur la défense de Namur en 1914. During the period Oct. 1923-July, 1925, the *Revue Militaire Suisse* published a series of articles by M. Jean Fleurier entitled "Une légende. La faillite de la fortification permanente pendant la grande guerre." Col. Merzbach and Capt. Comdt. Herbiet, of the Belgian Army, contend that M. Fleurier had not sufficiently complete information at his disposal to enable him to deal satisfactorily with the subject discussed in the articles above mentioned, and they assert that, in consequence, some of the deductions drawn by M. Fleurier in relation to the defence of Liège, Namur and Antwerp are erroneous. The two Belgian officers named have written an account—which they claim is more accurate than earlier accounts—of the frontier battles fought in Belgium in 1914; their account is based on the more complete information which is now available; the first part thereof appears in No. 2 of the *Bulletin.*

Emploi de l' aéronautique de corps d' armée. The original article, which is an important and interesting contribution relating to functions of the "Fourth Arm," is published in No. 2 of the *Bulletin*; its author deals in considerable detail with the several problems connected with the employment, in military operations of some magnitude, of the aerial arm in combination with land forces.

Le vide du champ de bataille. The expression "le vide du champ de bataille" was coined to be descriptive of the seeming "emptiness" of the territory occupied by the combatants of the Great War. The early experiences of the Great War showed that former methods of obtaining "intelligence" were by themselves inadequate; in consequence, aerial photography was called in aid to supplement them. The very remarkable results obtained by this means are described in an article by Capt. Comdt. Menzel, the first part of which is published in No. 2 of the *Bulletin*.

W.A.J. O'M.

HEERESTECHNIK.

(*July*, 1926). *The Chemistry of Smoke-production*, by Dr. Stampe.

How are we to produce the particles of the size pointed out in the May No. of *Heerestechnik*, as necessary for smoke or mist for screening purposes? From the nature of things it can happen in two ways, either through breaking up larger particles of matter or through condensation of smaller particles, *i.e.*, one proceeds to what is required either from solids and fluids, or from vapours and gases. Many solids can be ground so fine that their particles float in the air. Owing to the machinery necessary and to the meagre results in cloud-production, this method has no application to the field. Fluids are capable of being forced by sufficiently high pressure through the narrowest of openings. This method is much used for military purposes. The detonation of an explosive embedded in a substance capable of producing smoke or mist will shatter it to minute particles. This is made use of in gas-shells. As regards condensation methods the use of water for mist-producing is ruled out by reason of its high vapour-pressure and the use of many other substances for the same reason. But there are still more limitations, which leave very few substances suitable as mist—or smoke—producers in the field.

1. The substance must be capable of production in large quantities from the available products of the home country.

2. It must be something that is used in peace as a trade article of the chemical industry, since owing to the masses of it which will be required in war, it would be impossible to stock a year's supply.

3. It must be cheap, otherwise the cost of screening a gun might exceed the cost of the gun itself.

4. It should be powerful, *i.e.*, produce large and thick clouds.

5. It must be non-poisonous, and should cause no harm to one's own troops.

6. In its non-gaseous state it should be as harmless as possible.

7. It should be stable for storing purposes.

Nothing has yet been found to fulfil these requirements, Nos. 5 and 6 especially are hard to satisfy.

The various mist—or smoke—producers can be conveniently grouped as those which require, and those which do not require, moisture in the atmosphere. Condensation of water on the particles that have been formed without moisture may, however, take place in group 2.

Group 1. (*a*) *SO_3 and its products.* SO_3 is a colourless liquid which boils at 115° Fahr. and evaporates at ordinary temperatures. The presence of water-vapour in the air causes a cloud of fine drops of H_2SO_4 to form. If much water-vapour is present, larger drops are formed, as the H_2SO_4 attracts it. This makes the mist formed by SO_3 much denser in damp air. The pressure of the H_2SO_4 vapour and also of H_2SO_4, H_2O is so low that the cloud formed by SO_3 is very lasting.

SO_3 solution in H_2SO_4, is a trade-article, which gives off fumes strongly in the air. It is more handy in this form but less productive of smoke.

$HCl\ SO_3$ may be considered (and is, indeed, formed) as a combination of HCl and SO_3. In the presence of water the HCl and SO_3 fall apart, H_2SO_4 being formed. HCl gas is so hygroscopic that it immediately forms HCl, H_2O. Even concentrated HCl gas has a low pressure so that again the cloud is a lasting one.

(*b*). *Tetrachlorides of Tin, Silicon, etc.* These also form acid-vapour with damp air,

$$SnCl_4 + 4H_2O = Sn(OH)_4 + 4\ HCl.$$

The corresponding hydroxides are delivered in the finest divided state so that the sulphur tri-oxide clouds, which are superior to tetra-chloride clouds in damp air, may be inferior to them if the air is fairly dry.

(*c*). *Phosphorous.* White or yellow phosphorus burns in the air giving off a white smoke, the pent-oxide,

$$P_4 + 5O_2 = 2P_2O_5$$

which is extremely hygroscopic.

$$P_2O_5 + 3H_2O = 2H_3PO_4$$

Like sulphuric acid, phosphoric acid is hygroscopic so that the cloud eventually consists of H_3PO_4, H_2O. As, in this case, oxygen is taken from the atmosphere as well as water-vapour, the effect is greater.

Group 2. To this group belong in the first place all smokes consisting of solid particles. At ordinary temperatures they have generally so low a pressure that the question of evaporation does not arise. Such smoke clouds are the oldest known for military purposes, being made on land by burning damp straw and such substitutes, at sea by checking the draught to the furnaces. Especially, modern war-ships burning oil-fuel can quickly throw out clouds of smoke, consisting of particles of soot and minute drops of water and of unburnt oil.

A thick cloud can also be produced by burning the by-products of the distillation of tar-pitch, anthracene, napthalene, etc. Similar results can be obtained by burning with insufficient draught brickets of these by-products to which have been added straw, saw-dust, peat or brown-coal.

Until smokeless powder replaced gunpowder, battle-fields were covered with combustion products of another kind, viz., the sulphate and carbonate of potassium. Nowadays black powder is burnt for smoke-formation in a mixture with saw-dust, pitch, tallow, etc.

(*a*) *Berger Mixture.* The essential parts of this are zinc dust and the tetrachloride of carbon, with a proportion of $NaClO_3$ as an oxidiser. Other constituents are Kieselgur, or magnesium carbonate, in order to soak up the liquid CCl_4, and generally NH_4Cl to delay the re-action, which is otherwise very fierce.

Re-action is started by an explosion and the chief constituent of the cloud is the zinc chloride produced. This cloud of course appears in dry air, but is even more effective in damp, since the $ZnCl_2$ is hygroscopic and HCl assists in the cloud-formation.

Berger mixture does not fulfil Condition (5), being very unpleasant to work with. This is possibly due to the formation of small quantities of phosgene.

(*b*). *Tetrachlorides.* The tetrachlorides already shown in Group 1, as needing moist air for the formation of cloud, are included in Group 2 also, since with the aid of ammonia they can be used as cloud-formers in dry air. Especially $SiCl_4$ has thus been much used from aeroplanes, the solid NH_4Cl being formed when $SiCl_4$ and NH_3 are intimately mixed as spray.

Comparative Screening Effects. Gibbs in "Clouds and Smokes" places the order :—(1) Phosphorus ; (2) $NH_3 + HCl$; (3) $SiCl_4 + NH_3 + H_2O$; (4) Berger-Mixture ; (5) $SnCl_4 + NH_3$; (6) $SO_3 + NH_3$.

Dr. Stampe thinks that in this list the ammonia and hydrochloric acid come too high and the sulphur trioxide too low. He would place SO_3 above Berger-Mixture except in the driest weather. J. Meyer in "Gaskampf" gives a list :—(1) Phosphorus ; (2) SO_3 ; (3) $SnCl_4$; (4) $TiCl_4$.

The discovery of figures, based on experiments and trials, to serve for comparison of the different mists and smokes offers a wide field for scientific investigation.

MILITARWISSENSCHAFTLICHE UND TECHNISCHE MITTEILUNGEN.

(*September-October*, 1926).—*The Capture of Belgrade in October*, 1915. After the Austrians were driven out of Serbia in December, 1914, they remained on their southern frontier facing Belgrade on the defensive, until the early autumn of 1915, when German G.H.Q. decided to resume the offensive against Serbia and Montenegro. For this purpose they sent von Mackensen and four Corps. What made such a reinforcement possible was the shortening of the Russian front consequent on the Russian retirement. What made the offensive necessary was the importance of opening up communication between Germany and Turkey, via Austria, Hungary, Serbia (to be eliminated), and Bulgaria (Germany's new ally). It is more than likely that the offensive against Serbia was part of the bargain with Bulgaria.

To Mackensen's Army were added two Austro-Hungarian Corps, and to one of them, the VIIIth Corps, fell the extremely difficult task, and so the honour, of capturing Belgrade. That it was able to do so is due, first and foremost, to the engineers, who for two nights running rowed pontoons

across the Danube under the Serbian searchlights and every species of fire. More than half the pontoons were lost during the first night, but 3½ battalions were landed and managed to hold on to the foreshore all day. The deficiency of pontoons was made up on the second night by means of country boats, and under the same opposition as before, 3¼ more battalions were carried across. It was this second success that decided the issue, since the infantry were able to get forward and into the city the next afternoon.

One may fairly agree with the author when he writes of what the engineers did, " Only troops animated with the best spirit and excellently trained can carry out such performances. It is in steady, earnest, purposeful work in peace that those foundations are laid which enable the Engineer to conquer with equal honour the enemy and the elements." The story is a thrilling one and the subsequent bridging operations are full of interest.

The Use of Tanks, Aeroplanes and Gas in Mountain-country, by Staff Capt. Angelis. Mountains have always had a considerable influence on the conduct of war. The attacker has always avoided them if possible, while the defender has looked upon them as his allies. Austria is a mountainous country, and Austrians should therefore focus their attention quite specially on mountain-warfare. But the Peace Treaty has disarmed them. Together with heavy artillery it has deprived them of tanks, of aircraft, and of gas, precisely those means which their opponents of yesterday and of to-morrow expect to be decisive in war. It is obvious that mountains must influence the use and effectiveness of all these means.

1. *Tanks.* It is often impossible to use tanks in mountain-country, and at best difficult. Defence against them is very easy. Employment in mass is not possible, but single light tanks, up to 10 tons, might be used with great effect, especially where not expected. Where the use of light tanks is possible all precautions must be taken to defeat them. As good main roads are often found in mountains, armoured cars must also be reckoned with. Here also the defence is easy.

2. *Aeroplanes.* Full and valuable use can be made of aeroplanes in mountains. Their effectiveness is to a certain extent diminished by the more rapid changes of weather there prevailing, and by the lack of aerodromes. On the other hand their work is made easier by the limitations as to movement, quartering and fighting imposed by the mountains on troops working on the ground. In extended mountain regions the lack of suitable landing-grounds may reduce the number of aeroplanes accompanying the forces. A.A. defence is easier because the A.A. artillery can be posted well up the mountains, and so drive the aeroplanes higher still, but more Anti-Aircraft defences will be needed in order to cover all dead ground which might be used for landing places. (*To be concluded*).

The Red Army of the Soviet Union (*continued*). The present law regarding Service for War was accepted by the S.U. Central Executive Committee on 18-9-25. It states that the privilege and right of serving in the fighting branches of the Red Army belongs " to the working classes " only. The non-working classes are put into Labour formations and have to pay a special tax. Besides contractors, merchants, the clergy, etc., there are

also included in this category farmers who own property and such handicraftsmen as employ others to assist them.

Military service consists of :—

(1). One month's preliminary training in the recruit's 19th year, and one month in his 20th year.

(2). Five years' active service, starting at 21, of which the fighting branches spend three "on unlimited leave," airmen and certain special services, two years, and the navy, one year.

(3). Service in the Army Reserve up to 40 years of age.

The physical state of the recruits leaves much to be desired, the percentage of physically undeveloped and sick far exceeding the figures for 1914. This is ascribed to the long years of war, hunger and want.

The Soviet Government places no great confidence in the peasants, but reckons more on the fidelity of the workmen, who are always sent to those branches which must be specially reliable. Thus, of the 1925 class, 33% of the workmen were sent to the Tanks and Navy, 26% to the Air Force, 20% to Signals, and 21% to the rest of the Army. On the same principles the Government distributes the Communists, who from forming 4 to 8% of all other branches, rise to 12% in the Tanks, 19% in troops for garrison duties in towns, 46% in the Navy and 100% in the Air Force. An important innovation in the Red Army is the admission of women to military service, working women being accepted as volunteers. A certain number of women are serving in the Army, some in the positions of officers, and last year also there were women amongst those who passed through the Military Academy at Moscow. The value of this innovation is yet to be determined. The word 'officer' has been replaced by that of 'commander.' Ranks have been abolished and badges indicate the post a man is holding. There is nothing to prevent a brigadier from taking command of a battalion or even of a company, though it is seldom done. An officer can, however, revert without disgrace. The chief requirement of a candidate who wishes to become an officer is that he should be politically sound. No educational standard is obligatory, and for Infantry and Cavalry Schools little more is required than reading, writing, and the four rules of arithmetic. The age limits are :—Company Chief 33, Battalion Commander 35, Brigade Commander 40, Chief Leaders (Generals), 45.

The objects of getting rid of officers so young are to increase the Reserve and to keep close connection between the Army and the working population, so as to keep an officers' class from coming into existence. It is, however, very noticeable that the Red Army officers imitate the officers of the old Imperial Army and that they keep aloof from the soldiers, although they come from the same class in life.

The pay of the Red Army officers is by far the worst in Europe. A distinctive feature is the appointment of "political leaders" to all units down to companies. They assist the commanders in political affairs. The officers do not care for these political leaders, looking upon them as having insufficient work to justify their positions. Another peculiarity is the Military State Advocate, who plays a great rôle in the Red Army. He is appointed to watch the officers' activities, but assumes a guardianship, which is so noticeable to the soldiers that they

prefer to make their complaints to the State Advocate instead of to their own officers. (*To be concluded*).

F.A.I.

COAST ARTILLERY JOURNAL.

The Coast Artillery Journal for September, 1926, contains a suggestion that the psychology underlying the term "Anti-Aircraft Defence" is incorrect and promotes a misleading idea of the function of that branch. To avoid the belief, said by the writer to be almost universal amongst the American public, that the Aircraft and Anti-Aircraft Services are antagonistic and are rivals for the biggest helping from the national purse, he suggests that the name of the latter should be changed to the "Sky Defence Service," so as to spread the knowledge that it is a necessary and very efficient helpmate to the Air Service. He argues that as "one gun on land was equal to one ship at sea," it was shown in the last war that "one gun on land was equal to one Zeppelin in the air," and therefore that one satisfactory anti-aircraft gun on land should be nearly equal to an aeroplane in the air, because, no matter how strong, how daring and aggressive an Air Force may be, it cannot prevent incursions by the enemy over some part of the territory which it guards.

In the October number a survey of the History of the French Coast Defences shows how that service was starved by successive rulers and politicians of all tenets, of all ages and on many different occasions, until the imminence of war, each time, necessitated unbalanced expenditure.

Also an article on "Coast Artillery—Fixed or Mobile," asserts that the superiority of land defences over fleets is still considerable. The writer quotes the trouble caused by mobile light batteries in the early days of the Dardanelles fighting, and draws the conclusion that the Artillery in Coast Defence Fortresses should include mobile medium calibres, as well as light, so as to be able to inflict actual damage to ships. Search-lights also to be mobile. Such mobile armament could be used on the land front if necessary. As rails are a source of weakness, cross country traction must be developed for the purpose, with the necessary supports and cramps for ensuring rigidity and stability in action.

The Remington Arms Company are said to have brought out a new priming mixture to be used with rifle cartridges, which eliminates rust, corrosion and barrel pitting. The makers assert that when cartridges containing this new priming mixture are used exclusively, it is not necessary to clean the inside of the barrel at all. The mere use of the mixture renders the ordinary rifle barrel rustless and stainless.

The November number contains a scientific analysis of the Art of Teaching in connection with the Army, or Military Pedagogy as it is called. It concludes with the dictum that "we do not teach unless someone learns," which seems to put the onus on the correct member.

D.M.F.H.

CORRESPONDENCE.

"NOTES on the CAMPAIGN in FRANCE, 1914."

To the EDITOR, *The R.E. Journal.*

DEAR SIR,—May I be allowed to make clear the point raised by the critic of my 1914 book in your very interesting *R.E. Journal.*

My appreciation was an attempt to show the line of thought which led the French and Germans to act as they did.

The actual plans were as follows:—

The French original plan was:—After concentrating in five Army Areas on a front of 210 miles, to take the offensive with their First and Second Armies south of Metz and with their fifth Army north of Metz. Their Third Army was to form their connecting link between the two attacks. Their Fourth reserve Army was to be ready to strengthen either the right or the left attack. 24 Active Corps (48 Divisions), *plus* 14 reserve Divisions and 10 Cavalry Divisions, were to be available for these operations.

The original German plan was:—(a) To concentrate in seven Army areas on a front of 228 miles on the Western front; 22 Active Corps (44 Divisions) *plus* 28 reserve Divisions and 10 Cavalry Divisions; that is, 72 Divisions and 10 Cavalry Divisions. Twenty-six of the 72 Divisions and five out of the 10 Cavalry Divisions were allotted to the First and Second Armies on a front of 38 miles. (b) To allot to the Russian Front three active corps (6 Divisions), *plus* three Reserve Divisions and one Cavalry Division. (c) To seize Liège by a '*coup-de-main*' if the Belgians refused to allow them a right of way through this town, and to be deployed on the line Strasbourg—Metz—Thionville—Liège—Hassalt by the tenth day of mobilization; twelve days later to reach the line Ghent—Mons—Maubeuge—Mezières—Sedan, and by the thirty-first day of mobilization to be on the line Abbeville—St. Quentin—Metz—Strasbourg; then to continue the wheel of the first five Armies so that the first Army passed west of and south of Paris. (d) Finally, to reinforce the First Army with all available troops so that it could advance east and drive the French Armies against the Jura and Switzerland.

The original plan for the B.E.F., if it arrived, was to land at Boulogne—Havre—Rouen, and to concentrate on the area Maubeuge—Hirson—Le Cateau, with one Cavalry Division, or Cavalry Brigade, and either six or four Divisions, in time to be ready to march from the concentration area on the sixteenth day of mobilization to the left of the line of the French Armies.

The Belgian plan was to utilise Liège and Namur as bridge heads on the Meuse to hinder any enemy from crossing the Meuse from France into Germany or from Germany into France. Her six Divisions and one Cavalry Division were grouped so as to be able to confront quickly, German, French, English or Dutch armies. Antwerp was prepared as a final rallying point for her army.

Yours faithfully,

(*Signed*) A. KEARSEY,

late *Lieut.-Colonel, General Staff.*

5, Lexham Gardens, S.W.5.

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THE R.E. WAR AND R.E. KITCHENER SCHOLARSHIPS.

INFORMATION regarding these educational scholarships may be obtained on application to the Secretary, Institution of Royal Engineers, Chatham. The scholarships are of two kinds: "A," of value not exceeding £55 per annum and tenable between the ages of 10 and 18; and "B," of value not exceeding £20 per annum and tenable between the ages of 11 and 16. The *R.E. War Scholarships* are still restricted to the children or dependents of officers and other ranks of the Royal Engineers who were killed or died of wounds or disease contracted on service, or were permanently disabled, in the Great War. The *R.E. Kitchener Scholarships*, which are unfortunately very few in number, are open to the children or dependents of all officers and other ranks of the Royal Engineers who have either died or been permanently disabled while actually serving.

MONTGOMERIE PRIZE.

ATTENTION is invited to the conditions under which this prize, in value about £10, is offered for competition each year.

1. The Prize is awarded by the Council of the Institution of R.E. in the manner considered best for the encouragement of contributions on professional subjects by R.E. officers, to the Corps publications. It has been decided that the Prize shall be confined to officers on the Active List not above the rank of Substantive Major

2. The Prize shall consist of (*a*) a book on Survey, Exploration, Travel, Geography, Topography, or Astronomy; the book to be whole-bound in leather, and to have the Montgomerie book-plate with inscription inside; (*b*) the remainder of the year's income of the Fund in cash.

The following are suggested as subjects for contributions:—

(*a*) Descriptions of works actually carried out in peace or war. (*b*) Invention. (*c*) Design (excluding works of defence). (*d*) Labour organization on work. (*e*) Scientific investigations generally. (*f*) Accounts of exploration work and surveys.

ARTHUR FFOLLIETT GARRETT PRIZE ESSAY, 1927.

Subject selected :—"Railway Work on Active Service."

The Essay should take the form of an appreciation of the Railway position and the railway problems to be met with in the circumstances outlined in the succeeding paras.

In it should be set forth fully the steps that would be taken to cope with the situation ; to facilitate prompt construction ; and to provide all necessary organization, staff, facilities, plant and stores to carry out construction and to ensure an adequate railway service.

(2). The Expeditionary Force consists of three Divisions and one Cavalry Division, with the normal proportion of non-divisional and L. of C. units, also four Squadrons, R.A.F.

Included in the L. of C. units are : –

One Railway Survey Unit,

One Composite Railway Company,

Two Railway Platelaying Companies,

One Railway Bridging Company,

Two Railway Operating Companies,

One Railway Stores Company,

One Advanced Railway Workshops Company,

One Base Railway Workshops Company,

One Railway Telegraph Construction Company.

One Railway Telegraph Operating Station.

also One Dock Company :

all at Small War Establishment and with the several departmental headquarters.

It is probable that the E.F. will be reinforced by one Division.

(3). The Base, which has accommodation for 8 ships at a time and limited facilities for handling loads in excess of 12 tons, is a railway-served port in a friendly country which cannot undertake military operations outside its own borders.

(4). The railway, which is 4ft. 8½in. gauge and single throughout its length, runs 300 miles to the border of the hostile State, against which operations are to be undertaken, and has one 40-mile branch at Mile 30.

(5). The E.F. will require railway communication 450 miles from the coast, *i.e.*, 150 miles into the territory of the hostile State, which is without railways.

(6). The following further railway information and intelligence has been obtained :

i. Railway in friendly State owned and worked by local private Company.

ii. Normal train service : –
- 2 mixed trains and 4 goods trains per diem, each way, to mileage 200 ;
- 1 mixed train and 2 goods trains per diem, each way, between mileage 200 and the terminus at Mile 300 ;
- 1 mixed train per diem, each way, on the branch.

iii. Crossing sidings average 10 miles apart.

iv. Line operated on Telegraph and Paper Order System. Home and Outer Home signals at stations.

v. Goods trains maximum loadings :—
- 270 tons gross, mileage 0—200 and on the branch ;
- 600 tons gross, mileage 200—300.

vi. Rolling Stock :—
- 70 main line tender engines,
- 15 shunting engines,
- 3 10-ton (hand) cranes,
- 250 30-ton (bogie) trucks,
- 850 10-ton (four-wheeled) trucks,
- 80 passenger (bogie) coaches.

vii. 75 lb. rail ; wood sleepers, spaced 3ft. centres.

viii. Ruling grades :—
1/40, mileage 0—200 and on the branch;
1/100, mileage 200—300.

ix. Fuel, (imported) coal.

x. Water plentiful, but loco. watering plant only sufficient for present train service.

xi. Loco. heavy repair shops at Base.

xii. Engine depots at mileages 0, 100, and 200.

xiii. Reserve of permanent way and other materials small.

xiv. Line poorly ballasted except between mileages 0—100 and 200—250.

(7). The enemy only partially trained, but mostly officered by Europeans, and having modern field artillery and aircraft and good anti-aircraft defence, has raided the friendly country for 50 miles and destroyed, or partially destroyed, the railway as far as mileage 250. At this point he is held by the forces of the friendly State, but cavalry raids have been made on the L. of C. as far back as mileage 200. The railway has been restored to mileage 240.

(8). At mileage 260 is a bridge of 8 spans of 100 ft. over a river not more than 200 ft. wide, with a maximum depth of 6ft., except in the flood season, when the river rises as much as 10ft. for short periods and is 600 ft. wide.

There are no other big bridges between mileages 240 and 300, but several small bridges, including some of 40 ft. and 50 ft. span.

(9). Maps of enemy State are inferior.

The country beyond the border of the friendly State is comparatively easy for the first 50 miles; for the next 50 miles it is more broken and gradually rising, probably necessitating some rock cutting and a ruling grade of 1/40; beyond this it is again comparatively easy.

There are three rivers to be bridged, one at the border, a mile beyond the terminus at mile 300, and the others at approximately 50 and 100 miles from the border The rivers are comparatively small streams in the non-flood season, and are not more than 5 ft deep, but are liable to 10 ft floods and are 200 to 300 yards wide when in flood.

There is no surface water except from these three rivers. The villagers obtain their water from wells, but the yields are somewhat precarious except in the flood season.

(10). Operations start from railhead, mileage 240, early in December. The floods generally commence about mid-April and last till the end of June.

(11). The Commander of the E.F. anticipates but little serious resistance and has informed you, his assistant Director of Railways, that this progress will depend on the rapidity with which a railway L. of C. can be constructed and worked. He also informs you that the strength of the R.A.F. with the E.F. is slightly superior to that of the enemy Air Force.

(12). Roads are practically non-existent in the enemy territory, and such as there are will require much attention before even medium M.T. can be used, whilst there is no road metal nor ballast except between mileages 200 and 250 in the friendly State and from 50 to 80 miles from the border in the hostile State.

Essays must reach the office of the Secretary, Institution of R.E., Chatham, not later than the 30th NOVEMBER, 1927. Essays must not be signed but each essay must bear a pseudonym, and the name of the writer, enclosed in a sealed envelope marked with the same pseudonym, must be attached.

The following are the conditions of the Arthur ffolliott Garrett prize :—

1. The prize, which will take the form of a piece of plate, to be chosen by the recipient, was instituted by Mrs. Garrett in memory of her late husband, Major Arthur ffolliott Garrett, O.B.E., R.E.

2. Qualifications of the recipient: To be an officer on the Active List of the Royal Engineers, not above the substantive rank of Captain on 1st January, 1927.

3. The essay must not exceed 10,000 words.

MOUNT OPHEL, JERUSALEM.

A Compilation of the Results of the Excavations made between 1867 & 1925.

No modern detail is shown on this map.

SOURCES.

1. Ordnance Survey of Jerusalem; by Capt. Charles W. Wilson, R.E. (Ordnance Survey, Southampton, 1865).

2. The Recovery of Jerusalem; by Capt. Wilson, R.E., and Capt. Warren, R.E. (Richard Bentley, 1871).

3. The Jerusalem Volume (with portfolio of plates) of the Survey of Western Palestine; by Col. Sir Charles Warren, K.C.B., G.C.M.G., R.E. (Palestine Exploration Fund, 1889).

4. Excavations at Jerusalem, 1894-7; by F. J. Bliss, Ph.D., and A. C. Dickie, A.R.I.B.A. (Palestine Exploration Fund, 1898).

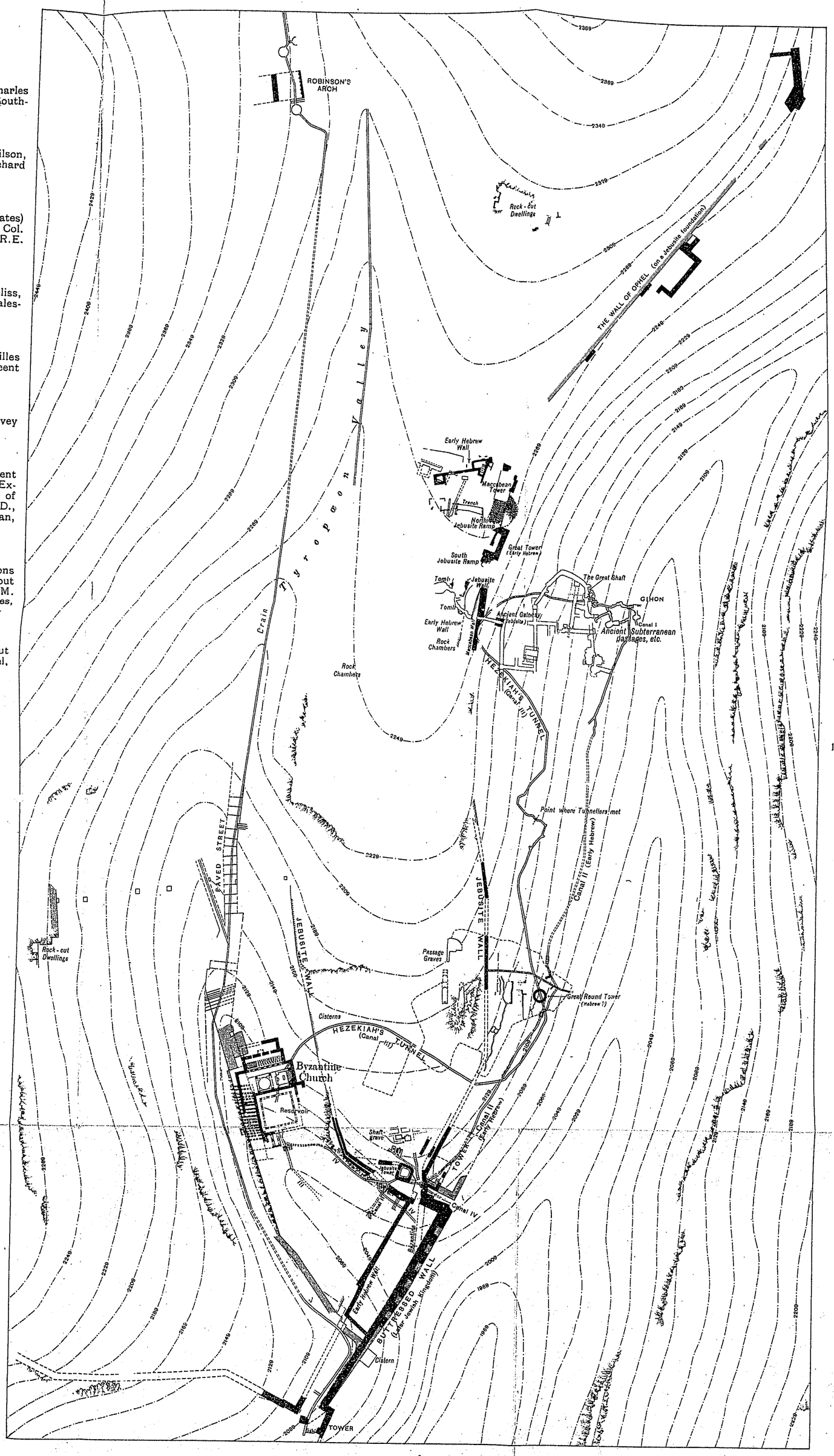
5. Jerusalem sous Terre: les Récentes Fouilles d'Ophel; décrites par Pére Hughes Vincent (Horace Cox, 1911). *Revue biblique.*

6. The 1:1000 Map of Mount Ophel; by the Survey of Palestine, 1922.

7. Palestine Exploration Fund Quarterly Statement for 1923-1925: Reports on the Palestine Exploration Fund Excavations on the Hill of Ophel, by Prof. R. A. S. Macalister, Litt.D., F.S.A., and the Rev. J. Garrow Duncan, M.A., B.D.

8. La Cité de David—An account of Excavations at the Southern end of Ophel, carried out (1913-14) for Baron E. de Rothschild by M. Raymond Weill (*Revue des Etudes juives, Vols. lxix and lxx*).

9. Plans of further excavations (1923-24) carried out by M. Raymond Weill at the S. End of Ophel, from information furnished by him.



Compiled for the Palestine Exploration Fund by the Ordnance Survey, 1926.

BRIEF ACCOUNT OF THE PRINCIPAL EXCAVATIONS AND SURVEYS ON THE HILL OF OPHEL, 1867-1925.

1867–1870. On behalf of the Palestine Exploration Fund, Lieut. C. Warren, R.E., and a party of Royal Engineers, carried out excavations on Mount Ophel and elsewhere. They discovered the Wall of Ophel; sank a line of shafts across the Tyropœon Valley and on the hill, and determined the rock contours; discovered the Great Shaft or "Gutter" leading from Ophel to the Virgin's Spring; and mapped the course of Hezekiah's Tunnel.

1873. Lieut. C. Conder again mapped the same tunnel.

1880–1881. Mr. C. Schick and Dr. H. Guthe carried out excavations round the out-flow of Hezekiah's Tunnel and on the southern slopes of Ophel.

1894–1897. On behalf of the Palestine Exploration Fund, Mr. F. J. Bliss and Mr. A. C. Dickie explored the Southern Wall of the City, discovered the remains of a Byzantine Church, N. of the Pool of Siloam and explored the Buttressed Wall to the S.E. of the Pool, and the Paved Street and Drain leading from the Tyropœon Valley.

1909–1911. During the excavations of the Parker Mission, the water in Hezekiah's Tunnel being diverted and the tunnel cleared of silt, the Rev. Father Hugues Vincent, made fresh surveys of the tunnel and of the associated subterranean workings, and discovered certain prehistoric Burial Caves, additional galleries and the Ancient Gateway.

1913–1914. On behalf of Baron E. de Rothschild, Mr. Raymond Weill carried out excavations at the S. of Ophel, discovered the Great Round Tower and the "passage-graves."

1923–1924. On behalf of Baron E. de Rothschild, Mr. Raymond Weill resumed his excavations at the S. of Ophel, discovered the Great Tower at the S. end of the Jebusite fortress, a "shaft-grave" and the S. walls of the fortress.

1923–1925. On behalf of the Palestine Exploration Fund, Prof. R. A. S. Macalister, and later the Rev. J. Garrow Duncan, carried out excavations to W. of Gihon, discovered the Jebusite Ramps, the Great Tower (early Hebrew), the small Maccabean Tower, and stretches of wall of the same period and fragments of walls of earlier date.