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2,250—1.12.41.

War Babies

THE WAR BABIES CHRISTMAS CARD.

The figures, reading from left to right, represent :—

Tunnelling Company
Artisan Works Company
Workshops Company
Electrical & Mechanical Company
C.R.E. Corps Troops
Boring Section
Tramway Company
Forestry Company
Searchlight Company
Sound Ranging Company
R.E. Park
Land Drainage Company
Gas Company
Pontoon Park
Base Park Company
Road Construction Company
Inland Water Transport Company
Port Construction Company
Signals Company
Camouflage Company
Siege Company
Army Troops Company
Pigeon Service

(Over all, birch in hand, stands the Corps Mother.)

THE ENGINEER-IN-CHIEF AND CHIEF ENGINEERS IN FRANCE, 1914-18.

(Extract from Corps History.)

Note by the Editor of the Corps History :—The introductory pages of this Article belong to a draft of the General Introduction to "Engineer Operations in France in 1914-18," but they are inserted here to explain the lack of Engineer Organization at the outbreak of war.

IN 1904 occurred the Esher Committee's "sabotage" of the Engineer organization at the War Office concerned with preparation for war. Under that organization the Inspector General of Fortifications and Works—as one of four principal staff officers of the C.-in-C., consulted also by the Secretary of State—was very efficiently carrying out the functions which nowadays are associated with the title "Engineer-in-Chief," with his own representatives on every important Committee in the War Office.

The Esher Committee's measures form an historical milestone in National Defence policy. The most outstanding results for which that Committee has earned the Nation's gratitude were (1) The expansion and acceleration in the evolution of the Committee of Imperial Defence, (2) the creation of a General Staff for the Army.

But the Esher Committee was not immune from the disabilities of all Royal Commissions and Governmental Committees.

There is always a great mass of inertia, vested interests, and powerful influences ranged against any recommendations for alterations of the "status quo," and above all against any increase in expenditure. These influences usually have some success in modifying the proceedings and recommendations of any Commission or Committee, and then they fight again with even greater success to prevent any serious action being taken on the report. The opposition's method is to pick out from their context any passages in the report that suit their ideas, and to bury the remainder in endless files of discussion on papers which are ultimately relegated to capacious pigeon-holes.

The Esher Committee by its prompt and powerfully supported action succeeded notably in contending against such strategy and tactics, but its report bears the marks of the influence of the usual doctrine, that if a new branch of organization, or some improvement is required, then it must be paid for by scrapping some portion of the existing organizations, however efficient and necessary to the balance of the whole that part may be.

While we congratulate the Esher Committee on the creation of a

General Staff, we must regret that they were forced, or at any rate deemed it expedient, to help to pay for it by depriving the General Staff of an existing organization for Engineer advice and co-operation in preparation of war plans and units and material. Many Engineers in subordinate positions continued to press their views, but without co-ordinating organization and representation at the top they could exert little influence.

This setback to Engineer organization and co-operation came at a time when modern warfare was about to become more and more dependent on the Engineer. An Engineer organization associated with the Staff had to be improvised as quickly as possible during the War, it was scrapped after the War, and as lately as in the present year we were still suffering from the effects of its absence.

The General Staffs of every nation before 1914 entirely misappreciated the character of the forthcoming war, and our own General Staff, groping in the myopic atmosphere of the Country and its Government, was no exception. They subscribed to the universal doctrine of a short war of rapid movement. No one would believe that human nature could support the long drawn-out and colossal sacrifice of life and material incidental to totalitarian war for $4\frac{1}{2}$ years. In addition, our General Staff, hampered as already stated, by the restricted views of the Country and its Government, had no conception of the size of the forces it would be compelled to employ, and moreover believed that in a war of rapid movement its small force of 6 Divisions could depend entirely upon the guarantee of its French Ally to maintain base accommodation, railways, roads and other communications. There was, therefore, on the part of our Army practically no preparation on a sufficient scale for speedy repair of demolished communications in the anticipated rapid advance, and of course no provision for the totally unexpected static warfare in trenches.

Hence we find that our *Field Service Regulations, Part* 1, (reprint 1914) on pages 18 and 19, Section 5, describe the characteristics and functions of Divisional R.E. Units, Bridging Trains (pontoons and trestles only) and Field Companies, but mention no other units. In Section 17, pages 38 and 39, we find reference to the duties and functions of Signal Units which are elaborated in Appendix 1. Otherwise there are no references in *F.S.R., Part* 1, to Engineer organization, duties and functions.

Turning to *F.S.R., Part* 11 (reprint 1913), we find in Section 23, para. 46, a definition of the functions of a Director of Army Signals, and also in Section 23, page 47, the duties and responsibility of a Director of Works in the Line of Communications. Section 59, pages 91 to 96, refers to the general organization of the military railway services, and the responsibilities of the Director of Railway Transport; while Appendix I, page 185, makes the M.G.O. respon-

sible for the provision of technical stores of R.E. units and of their vehicles.

The foregoing are the only references in the *Regulations* for Army organization, extant in 1914, which concern the functions of Engineers and their organization in an Expeditionary Force.

The *Regulations* of August, 1914, are completely silent about an Engineer-in-Chief and his Staff, or of Chief Engineers and their organization at Headquarters of Armies and of Corps.

Pre-war Control.—In pre-1914-war days the " Division " loomed in the eyes of the British Army as a very large formation. The R.E. certainly did not think of war in terms of armies and corps, any more than the bulk of the Army did. So we devoted much thought to the functions of a divisional C.R.E. but little to those of a Corps or Army C.E. and still less to those of an E.-in-C. In fact, there seemed to be little necessity for higher engineer control in those days.

Establishments.—Moreover, the officials referred to in the *Regulations* quoted were provided with a totally inadequate establishment to enable them to carry out their duties. Their startling inadequacy can be fully appreciated by comparing them with the *Establishments* of November, 1918, and the long list of many types of Engineer Units then in the field.

The reader's attention is directed to the one Brig.-General R.E. at G.H.Q. to act as technical adviser, with his two horses and one clerk. The Director of Railway Transport must have smiled when he found himself provided with a riding horse.

It was from these slender *Establishments* that an Engineer organization in every theatre of war had to be created and expanded as rapidly as possible to cope with the imperative demands of the biggest war in history.

Outline of Ultimate Engineer organization.—It is essential that the reader who did not take part in these events should at this point get a clear outline picture of the Engineer organization that existed in France at the time of the Armistice and (subject to adaptation) in other theatres of war.

Starting from the front there were the Divisional Units, each under a C.R.E. Divisional areas were grouped into and backed by a Corps area with a Chief Engineer on the staff of the Corps Commander, to whom he was responsible for all Engineer work in Corps and Divisional areas.

The Corps Engineer Units were each under a C.R.E. Corps Troops responsible to C.E. Corps areas were grouped into and backed by Army areas, each with a Chief Engineer Army, on the staff of the Army Commander and responsible to him for all Engineer work in the area of the Army and its Corps. Army Engineer Units were under a C.R.E. Army Troops. Signal organization was similar.

Behind the areas of the Armies was the zone of the Line of Com-

munications where the Engineer work was executed by the Director of Works, whose organization is not dealt with in this Article.

The Engineer-in-Chief was technically responsible to the C.-in-C. for all Engineer work, not only in Army areas but also in the Line of Communications zone. In this latter zone he delegated full responsibility to the Director of Works but retained control over the allotment of personnel and engineering resources to all parts of the theatre of war until, in April, 1918, personnel distribution was transferred to A.G. The Director-General of Signals, the Director of Railways, (later Director-General of Transportation, *i.e.*, Roads, Railways and Inland Water Transport) were also at G.H.Q.

The number and types of Engineer and Signal and Transportation Units created to execute the work are summarized on pages 64 to 67 of *Work of R.E. in the European War* 1914-18,—*Miscellaneous*.

This very rough outline of the Engineer-in-Chief's organization and functions will perhaps help the reader to follow the ensuing story of how it grew from such small beginnings into a big organization, so humorously summarized in the Engineer-in-Chief's Christmas card of 1917.

After the foregoing introduction to this subject the reader will not be surprised that on the way to France the Artillery adviser, Major-General Lindsay, remarked to his opposite number, R.E.—Brig.-General G. H. Fowke—"I don't suppose that you will have much to do in this War!" It should also be recorded that on arrival (in France) a single motor car was provided for the use of the two Advisers, and that their two clerks were thoughtfully allotted pedal bicycles to increase their mobility!

Actually during the rapid retreat of the British Army from Mons to the Aisne, there was little that General Fowke could accomplish single-handed, though he undertook reconnaissance of successive defensive positions, and managed by personal exertions to effect the destruction of one or two bridges, notably one at Soissons.

After the move of the B.E.F. in October, 1914, from the Aisne to the section covering the Channel Ports, at Fowke's urgent representation Sir John French consented to the attachment of two officers* (Lieut.-Colonel J. E. Edmonds and Major R. N. Harvey) to Fowke for general duties, including collection of Engineer intelligence, liaison with the French, and later for work on defensive positions. Shortly afterwards the First Battle of Ypres resulted in the stabilization of the front, G.H.Q. being located at St. Omer.† This inaugurated the

* The Staff of the E.-in-Chief, exclusive of attached officers, numbered :—
In August, 1915— 5 Officers.
" " 1916— 9 "
" " 1917—14 "
" " 1918—25 "
The Subordinate Staff increased to about 60 clerks and draftsmen.

† Here Generals Lindsay and Fowke (known to the General Staff G.H.Q. as The Bing Boys) and their assistants were allotted one room as an office: the assistants shared one table.

period of stationary warfare which lasted for nearly four years.

For warfare of this character no provision had been made, either in personnel or equipment. However, Fowke and his two officers were exceptionally well qualified by their experience* to deal with the new problems as they arose, and to give authoritative advice regarding field works and siege operations. This was communicated to Formations through the General Staff in a series of field work notes and designs. The improvisation of hand grenades, trench mortars, periscopes, hyperscopic fitments for rifles and other material was taken in hand and an experimental section was then formed, in charge of an officer (Lieut. Adams, 2nd Bridging Train, R.E.) expert in mechanics, for the design, testing, and manufacture on a small scale, of the various weapons, appliances, projectiles, etc., which were hastily improvised to counter the German attacks.

In conjunction with the French, back lines of defence were sited and marked: notably the B.C.D. Line (Boulogne-Calais-Dunkirk) to cover a re-embarkation.

Works in Army Area.—In addition to railways, the French had undertaken also to construct and maintain all road communications in France, for our Army—by the agency of the *Sous-Commission du Service Routier*. It soon became obvious, however, that they could not fulfil their obligations, and in November, 1914, two officers (Lieut.-Colonel W. A. Liddell and Major C. C. H. Hogg) were appointed to General Fowke's office to co-ordinate and supervise work on roads and bridges in Army areas. It was realized, moreover, that new types of bridges would be needed during an advance to cope with the rapidly increasing transport, and the great weights to be carried. There were other pressing demands for accommodation, works and stores of all kinds, in the Army area, which were referred to G.H.Q., and it was necessary that provision should be made locally for these, since there was no agency for labour, stores, or works administration between the Director of Works, L. of C., and the C.R.Es. of Divisions.

Appointment of Chief Engineer, B.E.F.—The formation of the Second Army in the last days of 1914 clarified the situation. It was evident that the senior R.E. Officer at G.H.Q. could no longer be restricted to advisory functions, and imperative that he should assume administrative, and, in certain matters, executive powers, to cope with his growing duties and responsibilities. This, in fact, Fowke did without hesitation.

Although formal recognition of status was delayed, in January, 1915, General Fowke became Chief Engineer, B.E.F., and

* Both Fowke and Harvey had been Instructors in Field Works at the S.M.E. Fowke was a member of the British Military Mission in the Russo-Japanese War of 1905/6. Edmonds had for many years served on the Staff, and in the Intelligence branch of the War Office.

Lieut.-Colonel Liddell was appointed D.D.W., G.H.Q., to administer under his orders Works and Works Personnel in Army areas.

APPOINTMENT OF ENGINEER-IN-CHIEF AND CHIEF ENGINEERS OF ARMIES AND CORPS.

Two months later an official representation was made to the War Office by G.H.Q., regarding the changes in the position and duties of both Artillery and Engineer Advisers, but it was not until July, 1915, that an establishment was approved for the E.-in-C. and for Chief Engineers of Armies and Corps. These officers were formally given the powers of a Director of Works in respect of expenditure, purchases, etc., and, in addition, to acting in an advisory capacity of planning and executing Works under the orders of their Commanders.

In September, 1915, the E.-in-C. was authorized to correspond direct with Armies and Corps on matters connected with the design and pattern of Engineer Stores and general questions affecting R.E. equipment and issues.

Organization of E.-in-Cs. Staff.—The winter of 1914-15 found the opposing forces on the British Front in a position of stalemate. On both sides there was a great shortage of ammunition and of aeroplanes. A considerable proportion of the front was waterlogged, and not only was the construction of satisfactory defences difficult but any considerable movement on either side was impossible. Both the position and front of the B.E.F. facing Lille remained practically unaltered throughout 1915.

There was an acute shortage of R.E. Officers, caused by heavy casualties in Field Companies and an increase in the number of these Companies in the Establishment of Divisions. Consequently the Staffs of E.-in-C. and C.Es. were kept at a minimum.

In this period the E.-in-Cs. Staff functioned in two sections. *One Section* continued to give its attention to the provision of back lines and the instructions in field works of the new Field Companies, Infantry Battalions and, later on, Divisions as they arrived in France; and to keep the General Staff informed of the methods of trench warfare devised at the front.

Experimental work was continued, but the Armies were now manufacturing at Béthune and Hazebrouck their own improvised stores, and it became the principal duty of the Experimental Section to test and report upon the various types of trench stores, particularly hand and rifle grenades, trench mortars, rockets, flares, land torpedoes, smoke bombs, catapults, trench diggers, etc., submitted by inventors at Home and in the theatre of war.

Many of these inventions were ludicrously unpractical.

But the greatest development took place in mining. At the end

of 1914 it had become known that the Germans were mining on a definite system, and in view of the shortage of R.E. in the front line, a demand for special mining Units was raised. The creation and work of the large mining organization is not dealt with here, but we may record the arrival at G.H.Q. in February, 1915, of Major Sir J. Norton Griffiths, *M.P.*, of King Edward's Horse. By profession a Civil Engineer and Contractor of wide experience, very influential in the political and mining world, he was a forceful and dynamic personality. From the first he was associated with Major Harvey, who by this time had become Assistant to the Chief Engineer.

The use of gas by the Germans at Ypres, in May, 1915, raised entirely new problems, which in the first instance were referred to the E.-in-C., on whose recommendation the Special Brigade was organized under command of Lieut.-Colonel C. H. Foulkes, R.E., with the rank of Brigadier-General.

Following some sporadic bombing of G.H.Q., an anti-aircraft searchlight service was organized and remained directly under the E.-in-C. throughout the war. Three projectors arrived in July, 1915. By the end of 1916 there were 22 Anti-aircraft Searchlight Sections, and when the war ended there were 80, under an Inspector, Lieut.-Colonel W. C. H. Prichard.

The other Section of the E.-in-Cs. office, under D.D.W. G.H.Q., became engaged in a multiplicity of duties similarly involving engineering problems of a type and on a scale unprecedented in the British Army.

Road communications were administered in conjunction with the French, and to supplement local resources a number of R.E. units, practically untrained, were sent to France for road work early in 1915, but demands for additional front-line units caused their diversion to Formations. The training of these units to fit them for front-line work devolved on D.D.W. They were subsequently replaced in the summer by eleven R.E. labour battalions.

Depots of bridging material on canal barges were formed by Fortress Companies. Orders were also given for a considerable number of steel girder bridges, and designs were prepared locally for special types of canal bridges and equipment, by an experienced bridge engineer, attached to D.D.W. Memoranda of instructions for bridge work were compiled and issued to armies. Later, Major C. E. Inglis, Professor of Engineering at Cambridge, advised the E.-in-C. on this work. His valuable work is well known to the Corps.

Engineer Intelligence.—It was clear from the outset, however, that the future requirements of the Army in respect of roadwork, bridges, and water supply, could not be gauged accurately until a considerable amount of definite information regarding engineering and physical conditions in the area of operations had been collected. This intelligence was practically non-existent, both in the French

Army*, and in the Departments of the French Civil Administration. Two officers (Capt. G. J. V. Shepherd, R.E. and Lieut. W. B. R. King, R.W. Fus., Geological Survey of G.B.) were attached to E.-in-C. in May, 1915, and with the help of two engineers of the Belgian *Ponts et Chaussées* attached to D.D.W., the compilation progressed satisfactorily for about a year. Investigation was also made into existing and possible inundations† and sources of water supply, road metal, and other engineering information.

It was by use of this information and by close liaison with all branches at G.H.Q., Formations and L. of C., that the E.-in-C. was enabled to estimate future requirements in the matter of Stores and Equipment, much of which took months to manufacture and supply, This forecast of stores became one of the most important functions of the E.-in-C. when his duties and responsibilities were expanded. A portion of E.-in-Cs. Intelligence branch was transferred to the G.S. Intelligence.

Creation of new Engineer Units and Staff.—Simultaneously with the collection of intelligence came the provision and organization of units for engineering operations additional to those carried out by the Field Companies of Divisions. For the next few months both sections of the E.-in-Cs. Staff were continuously engaged on initiating and elaborating proposals for R.E. Staff, and the organization and equipment of new types of units, besides the mining units already mentioned.

For example, following the Indian System, Field Engineers (Civil Engineers of wide experience, with Temporary Commissions) were appointed to Corps, early in 1915, for miscellaneous duties on roads, water supply, accommodation, etc.

In the summer, the four Fortress Companies in France were converted into Army Troops Companies, serviceable units, equipped with motor transport and made capable of a wide range of duties. Eventually the number of these companies was increased to 52.

There were many other new units formed for Stores and Parks, and for the operation of Workshops, Forestry, Survey, etc.

The Engineer-in-Chief.—In February, 1916, General Fowke was appointed Adjutant-General to the Forces. His successor was Major-General Spring R. Rice, who had been Chief Engineer at Salonica. In September, 1917, he was succeeded by Major-General G. M. Heath.

* For example, French Intelligence maps did not show the Canal du Nord under construction at the outbreak of war, nor the Causeway, road and railway across the Somme near St. Valery.

† Thereby, in the summer of 1915, the Belgian Army was enabled to maintain a large inundation of the River Yser to neutralize a considerable length of front. Pumps supplied from England and installed on two barges pumped over 37 million gallons of sea water daily into the river channel. In winter these barges were used to lower the water level around defences near Béthune.

Development of Definition of Duties of E.-in-C. and Chief Engineers.

Except for the creation of the Third Army and an extension to the South as far as the Somme, there was not much change in the position of the B.E.F. in 1915; but with the advent in 1916 of large reinforcements, increase of ammunition, and development of Air strength, the E.-in-Cs. responsibilities were increased correspondingly.

A Memorandum on the Administration of Works in the Field, prepared by the E.-in-C., was issued by the Q.M.G. in January, 1916, to regulate the transactions of Engineer Officers in Army areas. C.Es. of Armies under the technical control of the E.-in-C., were charged with the administration of all works, labour, etc., required in Army and Corps areas: the administration and supervision of Advanced Parks, and other administrative and financial measures were prescribed. In respect of works, C.R.Es., Field Engineers and Unit Commanders were stated to be the representatives of C.Es.

Further steps were taken to regularize the position of the E.-in-C. at G.H.Q. and organize his staff. In a letter of April, 1916, it was laid down that the E.-in-C. should function under the C.G.S. in respect of operations and defence; and as regards Works, under the Q.M.G.; that he should be responsible for the provision of Engineer plant and stores; his financial responsibilities were defined, and he was authorized to communicate direct with C.Es. of Armies regarding works and their relations with the French authorities. Also in April, 1916, the establishment of the E.-in-C. at G.H.Q. was enlarged and reorganized. The post of Deputy Engineer-in-Chief was created and Colonel W. A. Liddell was appointed thereto.

This distribution of duties, and the status of the E.-in-C., were subsequently confirmed and placed on record by an *Army Order* issued on 1st January, 1917.

In March, 1917, another *Army Order* also defined the status and duties of Chief Engineers of Armies and Corps.

Later Developments.—As the British Army grew in size, and especially when offensives on a large scale began, armies and corps became the only more or less permanent institutions in given areas. Through them flowed a constant stream of divisions attacking or recuperating after heavy losses. So it became increasingly necessary for the larger formations to take control of many matters formerly left to divisions, in order to secure continuity of policy. This applied equally to engineering. As a result, the functions of C.Es. expanded. They were expected to get much more grip on the engineering work of their areas, and to turn the engineering picture into one connected whole.

They were expected to exercise some measure of control over the engineering of lower formations and, besides, to undertake

themselves work of all kinds extending far forward into the battle zone as well as far in rear of it.

At this period of the war the staff of a Corps C.E. normally consisted of 1 staff officer and 3 field engineers, and he probably had permanently under his orders :—

3 A.T. Companies, R.E.
2 or 3 Tunnelling Companies, R.E.
1 Company of a Labour Battalion, R.E.
½ M.T. Pontoon Park
1 Infantry Labour Battalion

supplemented by a varying number of Field Squadrons and Companies, R.E. and working parties drawn from miscellaneous units, such as the Special Brigade, R.E., the Corps Cavalry, Corps Cyclists, Squadrons of Cavalry, etc., etc., and as much horsed and lorry transport as he could persuade the D.A. and Q.M.G. of his Corps to place at his disposal.

Methods of Control.—Effective Engineer control within the limits above defined can be achieved by a combination of the following :—

(i) Engineer circulars. (ii) Standard specifications and designs. (iii) Engineer instructions. (iv) Inspections. (v) Reports. (vi) Conferences. (vii) Correspondence.

Inspector of Mines.—In the latter part of 1915 it had become evident that the mining operations required to be more closely co-ordinated, and accordingly in January, 1916, it was decided to create the appointment under the E.-in-C. of Inspector of Mines G.H.Q. Lieut.-Colonel R. N. Harvey was appointed to this post, with the rank of Brig.-General, with a Controller of Mines for each of the Four Armies. Norton Griffiths remained Technical Adviser at G.H.Q.

A notable addition to the E.-in-Cs. office in 1916 was the appointment of Major David, attached to the Australian Mining Corps, a Professor of Sydney University and a member of Shackleton's South Pole Expedition, as adviser regarding geological conditions in Mining operations. David had a world-wide reputation as a scientist, and his services were invaluable.

Camouflage.—In the Autumn of 1915 another new service had been born to the R.E. as a result of the French having established at Amiens a workshop for camouflage equipment, mainly connected with Trench Warfare.

The establishment of each Army and each Corps were now to include Camouflage officers, while a Controller of Camouflage was added to the E.-in-Cs. staff, Lieut.-Colonel F. J. C. Wyatt.

Accommodation.—The conditions in 1915 did not cause any considerable demand for accommodation of troops, who generally found billets in villages at that time undamaged by shell fire and

bombing. When, in 1916, a large concentration of troops on the Somme was contemplated it became necessary to provide certain hutted encampments and other shelters. The question became more acute after the close of the Somme battle, and led to the designing at G.H.Q. in the spring of 1917, of the Nissen Hut. The first order from G.H.Q. was for 47,600 huts of this pattern. The type was utilised in every European theatre of war and involved an expenditure of over £7,000,000. Major Nissen, who possessed great mechanical ingenuity and workshop ability, was chiefly responsible for this design, and for other types of shelters and many of the items of camp equipment and accessories which were issued to the troops in large numbers during the war*.

Bridges.—No considerable amount of Bridging was undertaken in 1916 but steady progress was made with the supply of steel bridges and equipment. Originally classes were formed at Havre Depot for the instruction of officers and men in the erection of steel span bridges, but these proved inadequate to deal with the personnel required. A Bridging School was established therefore at Aire in 1916-17 and subsequently moved to Monchy Cayeux. In all, some 400 officers and 2,000 men were trained in France.

A new type of bridge, designed by Professor Inglis, was tried and adopted. The original pattern, designed for Infantry only, allowed of bridging spans up to 100 ft. in a very few minutes, and modifications for heavier loads were taken in hand, with the result that the Inglis heavy bridge, permitting the passage of all but the heaviest type of Artillery and Tanks, was made in a fraction of the time which it would take to erect similar bridges of normal pattern. This type of bridge proved invaluable for hasty work during the final advance of 1918.

Early in 1917, in anticipation of an eventual general advance by the B.E.F., the bridging requirements for an advance of 50 miles were worked out in E.-in-Cs. office and orders placed for the material and stores.

A special type of bridge was designed by Captain Hopkins (a specialist in bridge design) and adopted in spans from 60 ft. to 120 ft.

Designs were also prepared for floating bridges for heavy loads, using service equipment. These bridges were frequently constructed at a later date.

A floating bridge with piers of 60-70 ton Thames lighters was assembled at Dunkirk in readiness for the passage of the Yser at Nieuport.

Water Supply on the Somme.—The concentration of large bodies

* The Nissen Hut, with a semi-circular corrugated iron roof, was designed to provide a stable, warm and weatherproof shelter for men in devastated areas. It was readily transportable, one to a lorry, and erected with great rapidity by unskilled labour. Each hut housed at least 20 men. Nissen type hospital huts and steel tents were also supplied in large quantities.

of troops and horses on the Somme in the spring of 1916 caused a revision of the equipment provided for water supply, and the provision of a large amount of material for use by the R.E. In this area, which closely resembles Salisbury Plain, there was practically no surface water except in widely separated streams, and it was necessary to sink wells or bore holes through the chalk sub-soil.*

The single Mechanical and Electrical Company then existing could cope with the maintenance of only a fraction of the plant, and by the end of the year it was found necessary to form five such companies, with enlarged establishments. Boring plant had also been procured, and successful use of air-lift pumps on the bore-holes, a novelty in military practice, greatly increased the supplies of water available. It was by these means only that the troops could be maintained in the area they occupied during and after the Battle of the Somme.

Stores and Equipment.—The organization for the supply of these is not within the scope of this article. Here we will only note that E.-in-C. and D.-of-W. each made forecasts of requirements. D.-of-W. was responsible for provision, storage and distribution of stores. Allotments of stores were made monthly to C.Es. of Armies.

Forestry.—In 1915-16 a small R.E. Unit was formed under Lieut. Mallinson to exploit the timber in the Forêt de Niéppe adjoining the River Lys. This Unit worked directly under the Deputy E.-in-C. until merged into the Directorate of Forestry, formed early in 1917 under Lord Lovat, for extensive operations both in Army and L. of C. areas. Eventually there were 11 Forestry and 2 Artisan Works Companies, R.E. controlled by the Directorate.

Schools of Instruction.—In addition to Mining and the Bridging Schools, established in 1916, a school of Training in Field Engineering was organized by the E.-in-C. at Rouen early in 1917, to which junior officers and O.Rs. were sent for short courses of instruction in the latest methods. In the winter of 1916-17 a school for senior Field and Army Troops company officers was formed at Le Parc, and lasted for about a year. It was re-established at Blendaques for the same period in December, 1917.

These schools were under the direct supervision of the E.-in-C.†

Tramways in forward areas.—The demand for these originated in Divisional areas. The tramways then became co-ordinated by Corps Head Quarters and soon by Headquarters of Armies and then by G.H.Q., who made E.-in-C. responsible. The line of demarcation, or rather the merging into the organization of light railways and again of standard gauge railways, was necessarily rather indefinite. Direc-

*Prior to the commencement of fighting, more than 100 power pumps were installed, and 120 miles of water mains were laid. As the battle progressed, these figures were largely increased.

†See *Work of the Royal Engineers in the European War, 1914-18,—Miscellaneous*, pp. 353 et seq.

tor General of Transportation was responsible for light railways as well as normal gauge and at the time of the Armistice his assumption of responsibility for forward tramways was under discussion.

Roads.—Distribution of Duties between E.-in-C. and Director General of Transportation.

The Battle of the Somme had thrown an excessive strain on the French railway and road systems, which caused a big transfer of responsibility from the French to the British behind the British front.

A Director General of Transportation (Railways and Roads) was therefore appointed. He took over roads in back areas, but in forward areas they remained the responsibility of the R.E. in Formations, who obtained material, stores and plant from the E.-in-C. The R.E. also continued to be responsible for the construction of all new bridges.

Final Distribution of Duties and Organization of E.-in-Cs. Office.

On the 27th October, 1918 (at which date the imminent collapse of Germany could not yet be guaranteed) the E.-in-C. approved the following reorganization of his office.

Distribution of Duties.

D. E.-in-C. (1).

Brig.-General H. Biddulph, D.S.O.

1. Operations. 2. Bridging. 3. Water Supply Operations. 4. Defence in Army Areas. 5. Inundations. 6. Tunnelling and Explosives. 7. Allocation R.E. Units. 8. Publications connected with above.

D. E.-in-C. (2).

Brig.-General J. E. Edmonds, C.B., C.M.G.

1. Training and Schools. 2. Camouflage. 3. Searchlights. 4. Electrical Power and Plant. 5. Publications, other than D. E.-in-C. (1). 6. Draughtsmen and Maps. 7. Experimental Workshops. 8. Stores (including Mining, Water Supply and Electrical and patterns from Base Workshops). 9. Engineer Equipment. 10. Engineer Intelligence of Country, etc. (including Geology). 11. Engineer Information from enemy and Allied sources. 12. Records of Operations. 13. Rear Defences outside Army Areas.

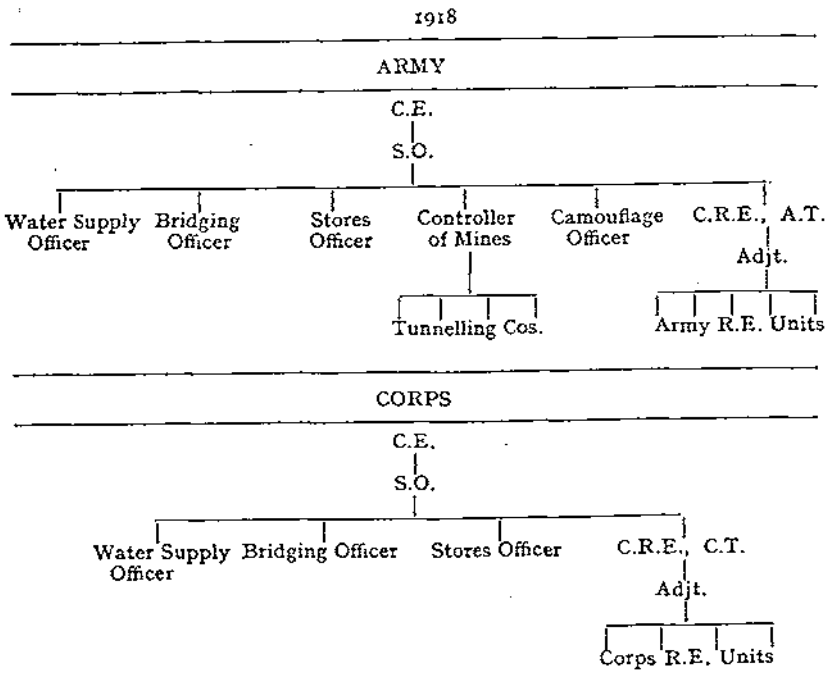
Organization of Office of Dep. E.-in-C. (1).

1. *Liaison and design of Field Works*, 2 officers. 2. *Tunnelling and explosives*, 2 officers and 1 medical officer. 3. *Bridging*, 2 officers. 4. *Inundations and Waterways*, 2 officers. 5. *Water Supply and Inspector of Workshops*, 2 officers.

ORGANIZATION OF OFFICE OF DEP. E.-IN-C. (2)

1. *Records*, 2. *Registry of Engineer Information, Maps*, 3. *Engineer information from enemy and Allied sources*, 4. *Draughtsmen*, 1 officer. 5. *Geology*, 2 officers. 6. *Experimental Workshops*, 2 officers. 7. *Searchlights*, 1 Inspector and staff. 8. *Camouflage*, 1 Controller. 9. *Electrical plant and power*, 1 officer. 10. *Stores*, 4 officers. 11. *Schools* (R.E. Tunnelling school. Bridging school. Field Engineering school.)

ENGINEER STAFFS. (ARMY AND CORPS).



*THE GERMAN FORCING OF THE PASSAGE OF THE MARNE 15th JULY, 1918.**

(With a Map.)

By BRIG.-GENERAL SIR JAMES E. EDMONDS, C.B., C.M.G., D.LITT. (OXON), *p.s.c.*†.

IN two previous articles were narrated " The German Passage of the Danube, 22nd-26th November, 1916 " against very feeble Rumanian resistance, and " The Austro-German Passage of the Danube and Save, 7th-17th October, 1915 " against the more determined resistance of the Serbians, without, however much assistance from artillery and without any air support. The present article deals with the forcing of a river against what the Germans conveniently called "*einen ebenbürtigen Feind,*" that is, an enemy equal in bravery and in the possession of similar up-to-date material.

After the failure of the German High Command to break the British front and cut off the whole British and Belgian forces by the great offensive of the 21st March directed towards Amiens, and the equal failure of the secondary effort begun on the 9th April, " the Battle of the Lys," directed towards Hazebrouck, with the reduced aim of cutting off only the British Second Army and the Belgians, Ludendorff, whose *Leitmotiv* was " the British must be beaten," tried a series of diversion attacks against the French front. They were designed to draw reserves from Flanders, and after that purpose had been accomplished he intended to return to this sector of the front and to smash the British for good and all. On the 17th July he himself actually went to Mons to superintend this operation, which, on the 20th, however, had to be abandoned owing to the failure of his offensive of the 15th, to which the passage of the Marne here described was the opening act.

The first diversion attack, begun on the 27th May, had been against the Chemin des Dames sector—an outline of it, with an account of the Engineer work performed in it has already been given in this *Journal*.† The French, with some battle-worn British divisions sent by Maréchal Foch to the sector for rest, defended the front

*Compiled from the German official monograph, *Das letze deutsche Angriff*; the German Engineer Book of Honour, *Das Ehrenbuch der deutschen Pioniere*; the French *Official History, Tome VI, Volume II* and *Tome VII, Volume I*; the British *Official History* " 1918 " *Volume III*; and histories of the various German engineer battalions, which, except that of the Guard Engineers, are poor as regards 1918.

†December, 1940.

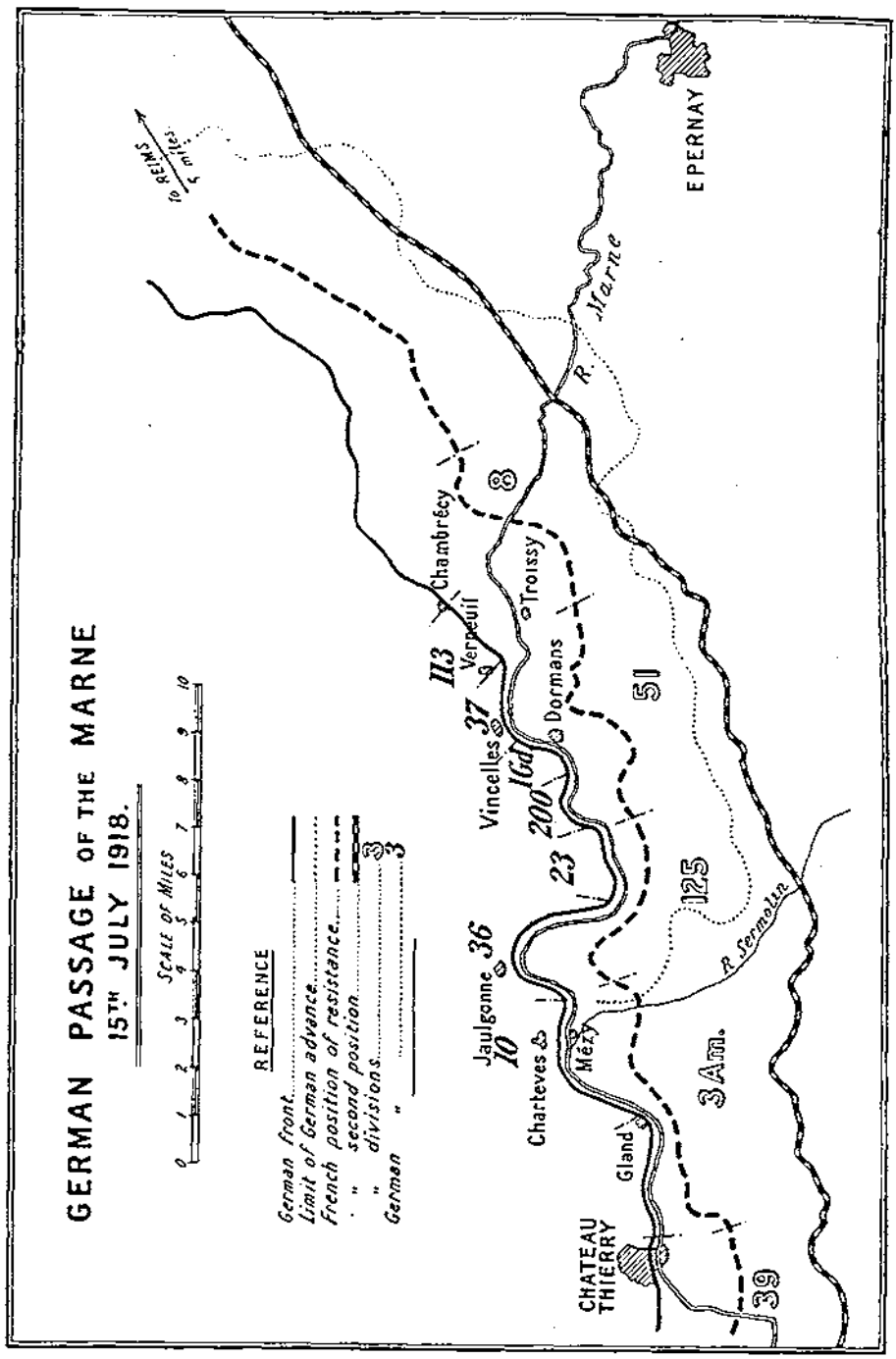
position and were swept away in the first rush ; but in the end the Germans only created another great salient.

The second diversion, begun on the 9th June, known as the Battle of the Matz, aimed incidentally at joining up the two salients formed by the offensives of the 21st March and 27th May. But the French, having learnt by experience, made their resistance this time in the rear portion of the " First Position," some 3,300 to 4,400 yards behind the front line, well out of range of trench mortars. On the third day, General Mangin counter-attacked from the west, so that the Germans gained very little ground ; but they did cause General Pétain to call for help from the British, and Sir Douglas Haig was requested by Maréchal Foch to keep a good part of his reserves behind his right wing, that is, near the international junction.

On the 15th July, Ludendorff began his third diversion attack on two wide fronts of 26 and 29 miles on either side of Reims ; he hoped that the mere threat to this town, the junction of a number of railways, which had held out in the front line for nearly four years, would cause Maréchal Foch to send all his reserves there. In the May offensive the Germans had reached the Marne on a 15-mile frontage from Dormans (15 miles below Epernay) down to Château Thierry, and the outposts now faced each other across the river. It was here that a passage was to be forced.

After the experience of the Matz the French commanders had come to the conclusion that the " Second Position " was the proper place to fight out a defensive battle. East of Reims, in old established defences, General Gouraud carried out this method with complete success, and, actually, the Germans stopped in front of his " Intermediate Position " between the First and Second ; but west of Reims, in the area to which the French had been driven by the May offensive, the defences were far from so well developed ; the construction of the Second Position was hardly begun. General Bethelot, who was in command there, decided to make the front of the Intermediate Position the line of resistance, even though in places this position consisted of no more than a single trench. Not liking, however, to abandon the line of the Marne and make no use of its value as an obstacle, he decided, with higher approval, to hold certain *points d'appui* in the First Position, and keep the outpost line on the banks of the Marne, with the result that " about one-third of the effective infantry was in the covering zone," more than enough to delay and disintegrate the attacking forces and much of it exposed to the enemy's preliminary bombardment.

The Marne between Epernay and Château Thierry flows with many a bend in a deeply cut valley, some 2,000 yards wide and 550 to 650 feet below the general level of the surrounding country. Its width is seventy to eighty yards and its depth 10 to 12 feet in


GERMAN PASSAGE OF THE MARNE
15TH JULY 1918.
SCALE OF MILES
0 1 2 3 4 5 6 7 8 9 10
REFERENCE
German front
Limit of German advance
French position of resistance
" " second position
" " divisions 3
German " 3
10 REIMS 4 miles
EPERNAY
R. Marne
Chambrécy
Verneuil
Troissy
Dormans
Vincelles
Jaulgonne
Charteves
Mézy
Gland
CHATEAU THIERRY
R. Sermoise
3 Am.
125
51
23
200
16d
37
113
36
10
8
39

summer, exposing at that season vertical banks as much as ten feet above the water level. Numerous smaller subsidiary valleys lead down to the trough of the Marne, the widest and deepest of which is that of the Surmelin stream on the southern side, which enters the river at Mézy. On the slopes, besides orchards, are the celebrated Champagne vineyards, which are continuous near Epernay. On the northern bank the slopes almost reach the water ; on the southern, from the heights of which the whole valley is overlooked, is a strip of meadowland with some marsh about a thousand yards wide, and on this side ran a railway and a main road. Here the woods extend well down into the valley, whilst on the northern bank the steep slopes are almost bare of trees, though crowned with very large woods.

In the two attacks, east and west of Reims, in order to " pinch out " the fortress, 49 divisions were to take part, 21 of the First and Third Armies on the east, and 18 of the Seventh Army on the west, with 10 in reserve. The orders to the last-named Army, with which we are concerned, were :

" Seventh Army will by surprise break through the enemy's positions between Gland (a little above Château Thierry) and Chambrécy (9 miles N.N.W. of Epernay) and gain possession of the passages of Epernay and of the heights south-east of the town." Near Epernay connection was to be made with the First Army, hence the special mention of that town.

Of the 18 attacking divisions of the Seventh Army, 11 were to be in first line and six of these, from right (west) to left 10th, 36th, 23rd, 200th, 1st Guard, 37th, were already up to the Marne, and the seventh, the 113th, only a short distance from it. They had forcibly to begin their operations by crossing the river. On the whole front of attack west of Reims were 6 French, 1 Italian, 1 American (in infantry double the strength of a French, German or British division), with 3 (one Italian) in reserve behind the right wing, and 3 (one American) behind the left. On the river front, to oppose the assault of seven German divisions were three French and one American.

No less than 456 field, 258 heavy and super-heavy and 652 trench mortar batteries were allotted to the Seventh Army, the process of artillery deployment beginning on the 5th July and being completed on the 13th, two days before Zero. All the available tanks were also sent to it, but were not used on the river front. The programme for the artillery bombardment was, 1st Period (10 minutes) general surprise fire at the highest rate from all guns and trench mortars, using mustard gas as far as available, against all infantry trenches, battery command posts, telephone exchanges, headquarters, billets, camps and bivouacs. 2nd Period (60 minutes) concentrated shell and shrapnel fire against batteries and continuation of fire against important points. 3rd Period (30 minutes) preparation of the

enemy rearward infantry positions for assault, systematic counter-battery work and the engagement of distant targets. 4th Period (120 minutes) preparation of the forward infantry positions for assault. Ten minutes before the end of this period the batteries were to be re-grouped for the creeping barrage.

After 3 hours 40 minutes bombardment, that is at 4.50 a.m., the barrage was to move forward with gas and high-explosive from guns in the advanced part and, 660 yards behind this, the main part, high explosive from heavy and light howitzers.

For the passage of the Marne 59 engineer companies were employed, 28 specially sent from the G.H.Q. reserve and the rest belonging to the divisions. Six corps and 29 divisional bridging trains were provided. The G.H.Q. companies were to ferry over the advanced guards and the divisional companies build the bridges behind them. In each division four infantry battalions were to be ferried over in pontoons simultaneously, and directly they were across bridge construction was to begin. According to the progress made with this construction the artillery batteries detailed to accompany the leading battalions were to be ferried over on rafts or be the first troops to cross the bridges.

For ferrying, 26 (including 2 spare) pontoons were allotted per division, and " light ferries " presumably boats or punts, for runners, despatch riders, wounded and prisoners. These ferries were to be replaced by floating footbridges as soon as possible.

Two bridges were to be built in each divisional sector, one " light " to take weights including the 5.9 inch howitzer, and one heavy to take 9-ton lorries.* They were expected to be ready at latest 3 hours 35 minutes and 4 hours 10 minutes respectively after fire was opened. If they were ready sooner each man of the company concerned would receive some additional rations and a monetary reward of 1 to 2 marks—such incentives to rapid work are unknown in any other Army except, it is believed, the old Chinese Army. Should it turn out impossible to have the light bridges ready in time, on account of enemy action or of the pontoons being required for ferrying longer than anticipated, the accompanying artillery, trench mortars and first-line transport were to be put over on rafts.

Besides its own two engineer companies, each division had at its disposal an engineer company and a whole G.H.Q. engineer battalion and two or more companies from a division of the second or third line. In addition, each Corps had as reserve two companies of a resting division. The three " position divisions " already in the line —which were not to attack—were to provide the carrying parties required.

* The difference between the light and heavy bridges was that in the latter the pontoons were closer together and more baulks used, and if necessary, double chessing.

On the Western Front, the German Engineers, owing to the long period of trench warfare, had had little practice in waterwork and handling bridging material under fire, their most important piece of work having been the crossing of the small Ailette stream in the Chemin des Dames battle. From the middle of June, therefore, all the engineer battalions in the Seventh Army, particularly those of the G.H.Q. reserve, were given special practice in pontooning and the passage of rivers by surprise. The period thus given to training reduced the time available for the engineer preparations on the spot to barely fourteen days, and there was a great deal to do. It had been decided to bring the bridging material as far forward as possible and hide it at assembly places in the great woods above the river; thence on the eve of the attack to carry the pontoons, etc., down the slopes to a starting line, from which they would be taken to the river, after the bombardment had begun. The assembly places had to be chosen, the approach roads, entrances and exits to them improved, the starting line marked, the sites of the ferrying places and bridges selected, and the routes to them marked, the pontoons prepared so that they could be carried noiselessly; besides, the material for extemporized bridging had to be collected; the infantry trained in carrying; command, report and observation posts constructed. And all this had to be done mostly by night.

Between the 9th and 14th July all bridging material and the pontoons were brought up and hidden in the woods about a thousand yards from the river. Life belts and lines, never used at manœuvres, were included, also corks to stop bullet holes—nothing was overlooked. The "starting line," marked by a broad white tape, was from three to four hundred yards from the river, so the first "carry" was six hundred yards or more. Little interference was caused by enemy fire during the preparations.

The night of the 14th-15th July was pitch dark and starless, with driving squalls of rain. Suddenly at 1 a.m., ten minutes before the bombardment was to begin, the French batteries opened fire. It fell behind the front positions and on the gun positions, command posts and approach roads, and caused casualties among the engineers and infantry on the starting line. The Germans could not know that the enemy had learnt of their intentions, even the hour of the opening fire, and at first thought their own artillery was shooting too soon and short. At 1.05 a.m., therefore, the pontoons were picked up, according to plan, and the carriers with their feet wrapped in grass and sandbags to deaden noise, dragged (*schleppten*) them down to the starting line, there to wait under the now recognized enemy fire for two hours. They suffered many casualties, some of the pontoons received direct hits and others were holed by the French harassing fire, whilst at Chartèves from time to time machine-gun fire swept the line. Nevertheless the pontoons were lined up and very soon the

first wave of infantry arrived and lay down behind the tapes. Then, as happened to the British at Loos and the Germans on the 21st March, 1918, the gas blew back on the front positions far into the hinterland, so that in some places even the staffs were forced to put on their gas masks.

At 2.50 a.m.,* that is two hours before the bombardment was to cease and the creeping barrage begin, all was ready for the advance and the pontoons were carried and pulled down the slope to the water, and five minutes later the first wave of infantry followed. The 10-foot drop into the river presented difficulties in some places, but by 3 a.m. nearly all the pontoons were in the water. The enemy posts on the other bank did not open fire, it was too dark to see anything, and the noise of the artillery from both sides drowned every other sound.†

In a few minutes the pontoons had been paddled across and the infantry, with the help of short ladders at some places, climbed up the steep bank. Each company, as soon as it was assembled, pushed forward a short distance to an embankment to wait until 4.50 a.m., the hour of assault. Meantime, the second wave of infantry had come down to the north bank and crossed the river as soon as the pontoons returned. Some machine guns were brought over in the pontoons and light trench mortars, with some officers' horses and single guns, on rafts. Lines were got out across the stream so that the pontoons and rafts could be hauled as flying bridges.‡

The building of the bridges was to be begun directly the first wave had reached the southern bank. The shore trestles were put together behind walls and copses and taken to the river at the double. At Vincelles the shore end of the heavy bridge was ready by 4 a.m., but the bridging train had not arrived, so no pontoons, except a few stray ones not required for ferrying, were available. Then at last the bridging train arrived, after having suffered *en route* heavy losses in men, horses and material. Instead of a heavy bridge, only a medium one could be built, and when the southern bank was nearly reached the roadway was hit by several shells, and only by great exertions was the bridge prevented from floating down stream. By 7.45 a.m., however, the work was finished and batteries began to cross.

At a number of other places, too, the bridges could not be built as projected owing to the heavy losses in bridging material. Instead of the heavy bridges, light bridges, even extemporized footbridges, were all that could be managed. "Where the bridges could not be

* Thus the official monograph. The Engineer Book of Honour says the signal to start was given at 3.05.

† Thus the official monograph. The Engineer Book of Honour says "at Dormans the enemy kept the ground continuously lighted up and had a barrage down on the front of the starting line which caused heavy losses."

‡ The History of the Guard Engineer Battalion, pp. 193-8, gives a good account of the details of the ferrying. Four detachments with six pontoons each were employed. The battalion lost 12 dead and 67 wounded.

built the pontoons which remained were used as ferries."* In the sector of the 37th Division a light pontoon bridge was built between 6.15 a.m. and 7.45 a.m. It twice received direct hits, one soon after the other, and many sappers were killed and wounded, but by 8 a.m. the light trench mortars, mountain and accompanying batteries of the division could use it.

As the day got lighter the accuracy of the French artillery fire increased, aircraft began to appear and drop bombs, and at some places, notably at Jaulgonne, machine-gun fire swept the bridges. The whole valley had been covered with an artificial smoke screen, but about 7 a.m. the wind changed to the west and cleared the smoke away. "From now onwards to be on the banks or on the water was real hell." Yet the engineers had to remain to keep the bridges in order, replace damage, stop holes in the pontoons and pump out the water. The casualties were heavy and amongst them, killed at Dormans, was Major-General Unversagt of the Engineers, who was in charge of the bridging operations, on whom, with his staff, an air bomb fell about 1 p.m.†

At Chartèves, owing to a counter-attack of the American 3rd Division, the troops had to retire across the river until "a direct hit sent the bridge with man and mouse to the bottom of the Marne."

In the "evening"—whether this was after or before the great air attack at 7 p.m. is not stated‡—the situation on the river, beginning on the western flank was as follows:

"In the 10th Division, owing to the shortage of pontoons, only one light bridge had been built. This was ready at 5 a.m. and, in spite of fire, had been kept open for foot passengers until 5 p.m., when it sank. For the withdrawal of the division at night, only a few rafts were available, and when the last man of the rear guard was over the pontoons were destroyed by hand-grenades, as they could not be hidden in the woods like the rest of the apparatus."

"In the 36th Division, owing to fire, no foot-bridges could be built during daylight, but in the evening a light bridge was constructed."

"In the 23rd Division, one light bridge was ready at 6.35 a.m. and a heavy bridge at 1.30 p.m., but in the evening the former received a direct hit and was destroyed, and from lack of pontoons could not be replaced."

"In the 200th Division, in place of the destroyed light bridges,

* Thus Engineer Battalion No. 27, which tried to build bridges near Jaulgonne and failed. At night it made one about a thousand yards downstream.

† History of the Guard Engineers.

‡ Squadrons of the IX Brigade, R.A.F., assisted the French air force: "they were mainly engaged against ground targets from low heights, and, in particular, in attacks on the numerous footbridges thrown by the enemy across the Marne, some of which were destroyed by bombing." Eleven British aeroplanes were shot down within the enemy lines and four were wrecked after being damaged in combat. British official history, *The War in the Air*, Volume VI, p. 414.

ferries and an extemporized bridge had to be used; the heavy bridge, ready at 7 a.m., was kept open only with the greatest difficulty."

"In the 1st Guard Division one light bridge was available from 6.20 a.m. onwards, the heavy bridge only after 4.30 p.m."

"In the 37th Division a light bridge was completed by 7.45 a.m.; this at 8 p.m. was turned into a heavy bridge; the second light bridge was not ready until 11.30 p.m."

"In the 113th Division one light bridge was available at Verneuil by 8.45 a.m. and the heavy bridge at Troissy at 4 p.m."

Thus, instead of seven light bridges, there were three, and one of these was not ready until "evening"; instead of seven heavy, there were five, and of these two were not ready until after 4 p.m. For once all had not gone "according to plan."

The engineers were so busy trying to make and keep going the pontoon bridges that they had no time on the 15th to think about building additional extemporized passages, and only a few were constructed during the following days, partly on account of the enemy's fire and partly because no spare pontoons were available for the parties placing and driving the piles. They were, besides, very vulnerable targets; so during the night of the 15th-16th a number of floating footbridges were constructed; but most of the hours of darkness were spent by the engineers in exchanging and repairing damaged pontoons, digging trenches for shelter against air attack, and such like.

As regards the general events on the Marne front on the 15th, the French Official account gives the following details:

"The outposts were nearly completely annihilated before the action by the enemy bombardment and, having lost the greater part of their heavy and light machine guns, could offer no effective resistance. . . . The Germans climbed up the slopes of the valley under a barrage of particular violence and reached the position of resistance, whose garrison had been seriously depleted by the bombardment." In fact, they broke into the position.

Only the American 3rd Division (Major-General Dickman) reacted. In its sector "the Germans did not succeed in penetrating the position of resistance. The Americans counter-attacked and captured about two hundred prisoners, killing many more." The effect, as we already know, was that the German 10th Division fell back, recrossed the Marne and took no further part in the action. To the German High Command it was evident that "the German attack as a whole had failed."*

It is worth recalling now that General Pétain at once lost heart. Maréchal Foch had already in preparation a great counter-attack on the west of the Marne salient to be launched on the 18th. "General

* Monograph, p. 202.

Pétain resolved to reduce the forces destined for the counter-attack," even to abandon it, not understanding that it is not essential to meet an attack in front, but better to assail it in flank or take the offensive at some distance away. He was of course overruled by Maréchal Foch in a personal interview, and he then clamoured for British help, which was exactly what Ludendorff hoped for and wished might be sent.

The 16th July brought no alleviation of the troublous situation at the bridges, for the French had not been driven sufficiently far back that their guns, with air observation, could not fire effectively on the passages of the Marne, and these were also continuously bombed from the air.

In the general situation, again to quote from the French account :

" The 16th was a day of hard fighting. Exploiting their success of the 15th, the Germans made noticeable and threatening progress both in the Montagne de Reims [between Reims and Epernay] and also in the valley of the Marne, and they captured an important part of the Second Position." A French counter-attack was made from the west against the German bridgehead, but " soon encountered energetic resistance " and " the advance stopped." Again, only the American 3rd Division accomplished anything : it " proceeded with success to mop up the Mézy loop ; in the evening of the 16th July there was not a German on the southern bank of the Marne west of the Surmelin."

" The 17th July was marked by lively fighting, the Germans renewing their attacks and the French counter-attacking. . . . To sum up the situation, on the front of the [French] Fifth Army [Marne sector] it remained unchanged. The enemy advance in the direction of Epernay had been brought to a halt " ; and by the end of the day 70 per cent. of the [German] bridging material had been shot to pieces, and the losses among the troops crossing the Marne had reached a terrifying height." At 5.30 p.m. preliminary orders for retirement were issued.*

On the 18th the great French-American counter-attack between Château Thierry and Soissons (25 miles north of Château Thierry) was launched with complete success and continued next day with greater success. On the afternoon of the 19th Ludendorff reluctantly gave the executive order for the forces across the Marne to be withdrawn. Every preparation had already been made for this.

To return to the bridges :

When on the 19th the retirement across the Marne was ordered for the ensuing night, each of the six remaining divisions had at its disposal one pontoon or one improvised bridge, except the 113th Division which had both, and so many footbridges (the 1st Guard Division had 20) that the passage could be carried out on a broad

* Monograph, p. 201.

front. The preparations made for the destruction of the improvised bridges and the rapid dismantling of the pontoon bridges were carried into effect, and some of the service material was saved. " Of the remains of the original 6 corps and 29 divisional bridging trains however, no more than sufficed to form 1½ corps and 3 divisional, trains could be found " ; the rest of the 35 were at the bottom of the Marne.

The human losses are, as usual, concealed by the Germans ; only those of the 28 G.H.Q. engineer companies which did the preliminary ferrying, have been published. They amount to : Officers, 8 killed, 28 wounded, 1 missing ; other ranks, 157 killed, 783 wounded, 52 missing. The 59 divisional companies, which constructed and maintained the bridges, must have suffered far more heavily. Thus the 24th Engineer Battalion (at Dormans) had such " very heavy casualties in its 3rd and 8th Companies that no hope was left of carrying out the bridging." The four G.H.Q. companies with the 37th Division at Vincelles lost one officer and one pontoon load in the ferrying of the first wave, but the divisional company which arrived to build a light bridge received such heavy fire that the work had to be postponed : " the companies making the other light and heavy bridge soon lost an average of thirty men, and the work had to be stopped for a time."

Had the French shown the energy of the Americans and counter-attacked at once, no German could have remained south of the Marne on the 16th.

ROYAL ENGINEERS IN EAST PERSIA, 1918-20.

IN the war of 1914-18 the attitude of Persia was a matter of anxious concern to the Indian Government. Frequent encroachments and pressure from Russia along her northern frontier and peaceful but dangerous penetration into her territories had engendered Persian hostility, and therefore a tendency to side with Germany and Turkey in their struggle with the Czar's empire.

But, sandwiched as she was between strong Russian forces in the north and the British Empire's control of the sea and her southern coast, Persia found it necessary to walk warily and avoid committing herself openly until the friends of her choice should be in a position to support her.

It was the desire to cut the connection between Persia and Turkey at Baghdad that had considerably influenced the decision to advance to that strategic place. But our enemies, Germany and Turkey, were unceasingly working to exploit the Persian situation to their advantage by sending skilful and energetic agents into that country ; and, what was more threatening, into Afghanistan. Habibullah, the Amir of Afghanistan, was fortunately convinced of the power of the British Empire and rightly gauged that the interests of his country would best be served by a strict neutrality. In this attitude he had practically no support from the leading men of Afghanistan, which was therefore a powder barrel that might be ignited either by the murder of Habibullah or, in spite of him, by the machinations of Turkish and German agents, particularly the latter.

In these circumstances the Indian Government arranged jointly with the Russian Government to spread a "Cordon," or net, just inside the East Persian frontier along the whole length where it marched with Afghanistan up to Russian Trans-Caspia, for the purpose of intercepting the enemies' agents and preventing them from travelling to and from the Afghan powder barrel.

In December, 1917, the peace of Brest Litovsk changed the whole situation. The Bolshevik Government, no longer our ally, had ceased to oppose a Turkish advance into Persia, an operation which was obviously not the approach of an ally but a conquering invasion. Persia now realized that Great Britain was her only friend and the Shah changed his ministers for others who were anglophil. But he was too weak to make any serious resistance, so that the danger of Turkish and German penetration to Afghanistan had considerably increased. Russia had withdrawn her portion of the East Persian

Cordon, and it became incumbent on the Indian Government to take it over right up to the frontier of Trans-Caspia. Moreover, a "Cordon" to trap enemy agents would no longer suffice. It might become necessary to send a considerable force to East Persia or even right up to the Trans-Caspia frontier. As a beginning in that direction a Military Mission under Major-General Sir Wilfred Malleson was despatched to Meshed by the Indian Government early in 1918.

The establishment of a Cordon of detachments and the maintenance of its supply and communications in East Persia had been a formidable task, but when it became necessary to convert it into a Line of Communications capable of maintaining a considerable force, and when the section previously held by the Russians was added to its length, the magnitude of the task was greatly increased.

The task of creating, organizing, administering and, in course of time, defending this great L. of C. was confided by the Indian Government to Brigadier-General W. E. R. Dickson, C.M.G., C.I.E. (late R.E.) with instructions that it was required "at once if not sooner," in fact troops began to use it almost immediately. The resources of Staff, personnel and material, placed at General Dickson's disposal at the outset were diminutive, and were very sparingly increased as time went on. The demand was for bricks without straw. The three most urgent matters were :—

(1) Improvement or construction of a road.
(2) Calculation of the amount, nature and distribution of the transport.
(3) Division of the line into Sections and organization and distribution of personnel.

Brigadier-General Dickson has written a very interesting book entitled *East Persia, a Backwater of the Great War*, in which he describes and explains how he and the energetic and resourceful people who worked with him established and worked a successful L. of C. in a wonderfully short space of time. Here it is only possible to give the reader a glimpse of the difficulties encountered, the methods adopted to surmount them and the personnel, including some Royal Engineers, who accomplished the task under Dickson's guidance. Reference is invited to the accompanying map, which is taken from General Dickson's book and is reproduced here by the kind permission of the General and of his Publishers, Messrs. Edward Arnold and Co., to whom we are indebted for the loan of the block.

In 1917-18 the Quetta-Mushki Railway was extended 120 miles to Dalbudin, thence to Mirjawa, on the Perso-Beluch frontier, and finally to Duzdab. Railhead was first at Juzakh and later at Duzdab.

East Persia may be considered to consist of three portions, two highland blocks, Khorasan and Qainat, north and south of each other superimposed on an elevated plateau, and, in the south, the Seistan

depression, which is a fertile area surrounded by an inhospitable wilderness. Dividing the two highland blocks is a tongue of the Central Persian desert. The highest parts rise to 10,000 feet and the passes between 7,000 and 8,000 feet. The climate varies from forty degrees of frost to tropical heat up to 120 degrees in the shade. From May to August a furious wind blows continuously day and night. Such were the difficulties which nature opposed to the establishment of a Line of Communications over 800 miles in length beyond railhead.

When Dickson arrived on the scene of his labours with a small staff, including Captain W. J. Good, formerly a member of the Calcutta Port Commission, he consulted the British Consul in Seistan and the Qainat, Major Prideaux, and, later, his successor, Mr. R. J. Gould, I.C.S., to ascertain what resources in personnel and material the country contained with which to make a start. The Consul had recently raised a Corps of Persian Levies, officered by British Officers from the 106th Hazara Pioneers, experienced in road-making. They had some of their Indian Officers and N.C.O's with them, also with much experience in road-making.

These Levies were placed at Dickson's disposal, and the 107th Pioneers soon arrived to help. With these, Major Lang, Commandant of the Levy Corps, did valuable work. Captain Stubbs, R.E., who had been commissioned from the Indian Public Works, had preceded Dickson to East Persia and was working with remarkable energy, with practically no trained assistants, on the Northern section. He collected his supervising staff and his labour locally and used miners from the turquoise mines at Nishapur and locally-made powder for blasting. He had a genius for discovering latent talent among the local population.

R.E. Officers and a welcome detachment of the 3rd Sappers and Miners soon arrived, and also the 104th (Indian) Labour Company. The following R.E. Officers were sent as Directors of Works :— Lieutenant-Colonels W. P. Pakenham-Walsh, J. A. Graeme, D.S.O. and L. E. Hopkins, D.S.O., O.B.E., and Major M. A. H. Scott, M.C., as Deputy Assistant Director. Other R.E. Officers were Captain A. Prain and Lieutenant Patterson, with the Sappers, and Lieutenants P. A. Bourdillon, C. F. A. Bird, T. J. P. Price and M. A. Scott. Persian gangs of coolies worked in the central sectors under the supervision of the Officers and N.C.O's of the Seistan Levy Corps.

By November, 1918, the road from Railhead to Meshed was fit for light mechanical transport.

The Line was organized into the following sections :—

Railhead, Juzakh to Hurmukh	100 miles
This was reduced by 30 miles when Duzdab became railhead.	
Hurmukh to Shusp	150 miles
Shusp to Birjand (Headquarters of the L. of C.) ..	102 miles

Birjand to Qain	67 miles
Qain to Turbat	160 miles
Turbat to Meshed	90 miles
Meshed to Askhabad	170 miles

Intermediate posts were established at Safadawa, Jumin and Kuchan in the longer sections, thereby reducing the intervals between posts to approximately 80 miles, which became the normal daily run for the M.T. convoys.

Roadwork.—The Government of India's instructions, issued early in 1918, were that a road had to be made and maintained fit to carry light mechanical transport, that is, M.T. vehicles running on pneumatic tyres, including ambulances.

Previously there was only a camel caravan track from Railhead to Turbat and from Turbat to Meshed a very inferior Persian road track. From Meshed to Askhabad the Russians had made a metalled carriage road, but it was badly in need of repairs. The first troops that marched up the Line followed the camel track and were provided with roadmaking tools with which they improved the track in places and made it passable. After a survey of the track it was decided to generally accept this alignment, as it followed a line of water holes in the southern sections. From Qain onwards the country is cultivated in areas. The road-making problem varied with the peculiarities of the country. Where the road traversed the hills there were no particular difficulties. But between the ranges there were sandy tracks where the greatest enemy was the wind, which had the effect of causing waves or ridges of sand to travel from place to place. An elaborately constructed road would be found to be completely submerged in a sea of sand in the course of a night. Expedients to deal with this were either to raise the road above the surrounding level to be swept clear by the wind or to coat the surface with a sort of matting made of twisted shrubs, which would sometimes make the travelling sand pass over the road instead of settling on it. But labour had always to be available to deal with the sand menace.

In the southern sections the camel convoys treading down the earth formation of the road gave it a hard smooth surface unaffected by rain and admirable for the passage of light military transport.

Owing to the difficulty of transporting materials no bridging of any importance was done. The banks of nullahs were ramped and the beds cleared of boulders.

Accommodation.—When the East Persian Cordon, and the E.P. Lines of Communication which succeeded it, were first started the troops were accommodated in the Persian villages or in serais. Later it was decided that, owing to the complete lack of sanitation in these villages, to their being hotbeds of disease of every kind, to the contaminated water supplies, and also for tactical reasons, hutted encampments, away from Persian habitations, should be constructed

to house the personnel of the posts, the stores and passing convoys, and to form defensive posts in case of a local rising or incursion from without. It should here be mentioned that the activities of the Line did not cease with the Armistice. Fighting with the Bolsheviks was taking place around Askhabad and, in 1919, Habibullah was murdered and we were now at war with Afghanistan.

The posts, together with the depots of stores and supplies, were made as compact as possible, in the form of rectangles, surrounded by ditches and barbed wire fences, with small defensible bastions at two opposite corners. In case of trouble the latter would enable them to be held with a few rifles or a couple of Lewis guns, thus freeing the garrison for active service outside.

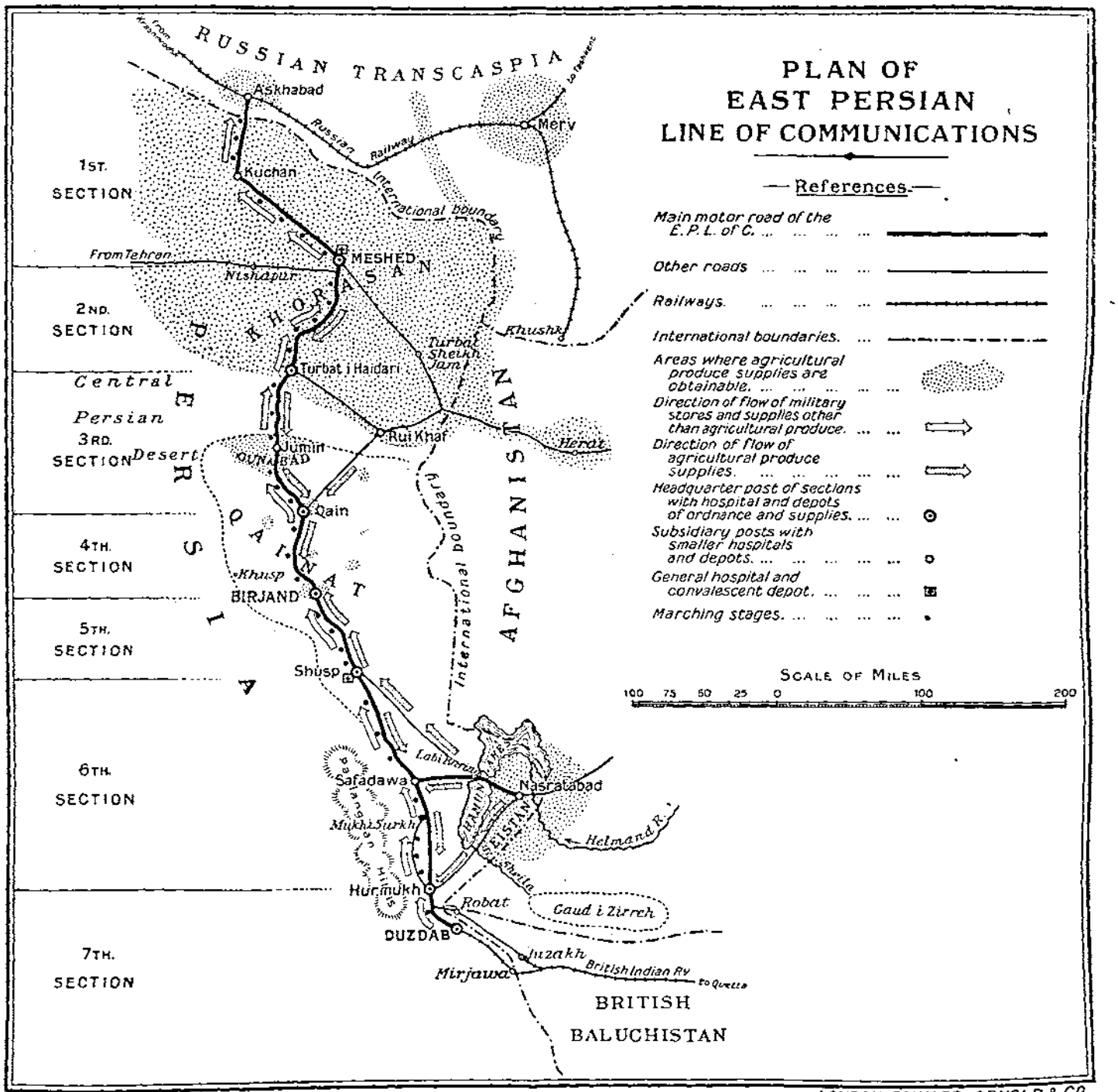
As regards hutting, the chief difficulty was the entire lack of timber except in the northern areas. In northern Khorasan, hutting followed normal lines, with mud walls and flat roofs. But in the central and southern sections transport difficulties rendered it impossible to import timber from India and recourse was necessary to the local practice of roofing with mud domes. This is as simple and cheap a form as can be conceived. The four walls having been built, the "gumbaziers," as the dome-masons were called, working entirely by eye, starting the dome simultaneously on all four walls, laid each layer of mud bricks, giving it the requisite slight tilt inwards, the mortar being increased on the outside, until the dome met in the centre. These domes, coated with mud and chopped straw, were perfectly rain and snow-proof.

Water supply.—In the defended posts there were Persian wells and in places boreholes were drilled. In the southern section the water was sometimes strongly impregnated with salts and had to be treated to make it potable without distressing consequences.

The outbreak of the Afghan War brought a serious menace to the Line, as it was known that there were Afghan troops, of uncertain quality, in Herat, in some numbers and others at Farah and at other points farther down in the south-west corner of Afghanistan abutting on Seistan. But Dickson's judicious organization of resistance to probable threats by grouping mobile columns at Rui Khaf and in Seistan, overawed the enemy and no serious trouble occurred.

In August, 1919, came the news of the Anglo-Persian Agreement and in November Dickson was summoned to Tehran to take up the post of President of a mixed Anglo-Persian Commission to consult on the reorganization of the Persian military forces. His successor in the command was Brigadier-General W. B. Lesslie, C.B., C.M.G.

The East Persian Line of Communications was maintained for nearly a year after Dickson's departure, and was finally withdrawn into India in the autumn of 1920.



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THE STORY OF THE B.E.F.

A LECTURE.*

By LIEUTENANT-COLONEL A. C. SHORTT, *p.s.c.*†, R.E.

DURING the year preceding the war, a Committee of three Officers —two of them Sappers—had been working out, at the War Office, the details of a plan to land the Expeditionary Force in the Western Ports of France. Personnel were to be put ashore at Cherbourg; guns and vehicles at Brest, Nantes, or St. Nazaire, where it was hoped they would be out of reach of the German short range bombers. From the ports, the Force was to proceed—personnel by rail, vehicles by road—to an Assembly Area some 100 miles west of Paris, around the towns of Le Mans and Laval, where Units were to reassemble, sort themselves out, and prepare for the forward move into their allotted positions on the frontier.

On September 4th, therefore, a party of Officers and Other Ranks, representing Advance Parties of G.H.Q., L. of C. and 1 Corps, the Staffs of the various ports, and personnel of the Movement Control organization, embarked at Portsmouth in two destroyers *en route* for Cherbourg. Minor mishaps befell both destroyers during the crossing, and night had fallen before we eventually berthed in Cherbourg harbour. Next morning, after a night spent in the Casino, buses, cars and lorries were commandeered in the town and parties dispersed to their several destinations—the majority to Le Mans, where those of the G.H.Q. Staff who had crossed by air were anxiously awaiting our arrival.

Early on the 6th, the four of us who represented the billeting party of 1 Corps (1st and 2nd Divisions) drove on to Laval, where we made first contact with the French Military Mission—also forming up at the barracks outside the town.

The personnel of the Mission were drawn from almost every branch of the French Army. They consisted of Officers, N.C.O's and Privates of good education and social position, who were experienced linguists, and skilled in the work of their own particular branch of the Service. Each Unit of the B.E.F. and each branch of the Staff was able, therefore, to count upon the services of an interpreter with expert knowledge in its own line of business. Tribute must be paid to the unstinted help and loyal co-operation

*This Lecture was given before the publication of Lord Gort's Despatches.

given, throughout, by these Liaison Officers and "Agents"—in the early days when unforeseen difficulties were daily encountered and, thanks largely to them, successfully surmounted; in the winter months, when inactivity sometimes led to indiscretions, and we had abundant need of their patience and tact, and in the dark days of May and June, when our good relations with their own Army were sorely strained, and when tempers at times wore thin. Even to-day, many of them still serve us as Officers or Privates in the ranks of the British Army. Whatever the ultimate relations between our two nations may be, we shall always owe a great debt of gratitude to the men of the French Mission.

* * * * *

On the 10th, Unit advance parties of the 1st and 2nd Divisions began to arrive in the Laval area, followed on the 20th by the first of the main bodies. By the 28th all was set for the forward move. Before dawn on that day I Corps began the first 150-mile stage of its long journey to the concentration area behind the Belgian frontier. It was our first experience of an operation on this scale since the advent of mechanization; many of the drivers had joined straight from the Reserve, and few had had previous experience of the right hand rule of the road. Except for a few minor "incidents," however, the move was completed without a hitch.

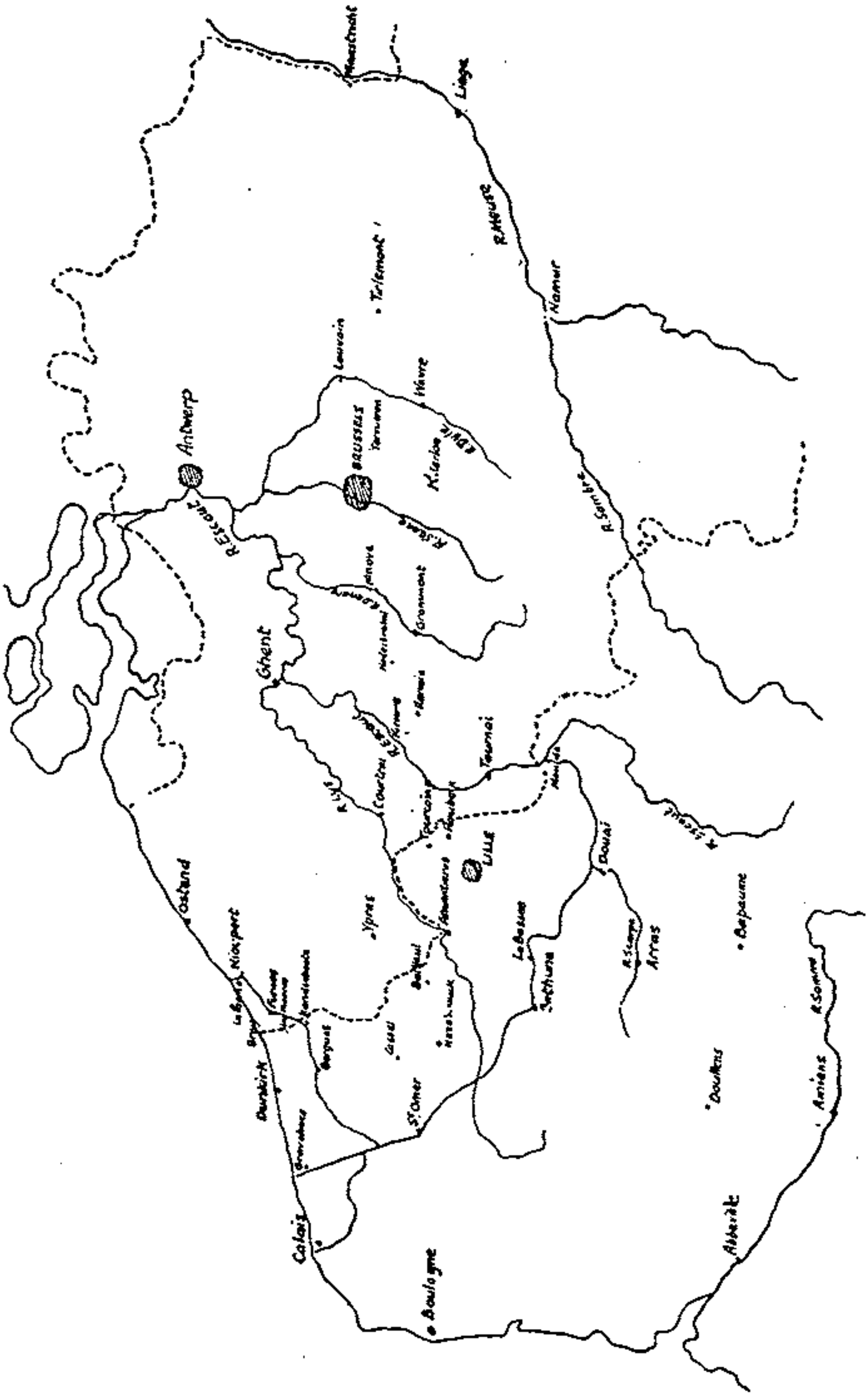
From the concentration area we moved into the line to take over from the French a sector of the Belgian frontier defences between the Fort of Maulde—N.W. of Valenciennes—and the outskirts of Roubaix.

A fortnight later 2 Corps—3rd and 4th Divisions—followed 1 Corps, extending our front east of Tourcoing to the Lys, then westwards along the river in the direction of Armentières.

The Maginot fortifications did not extend beyond Mauberge, but from there northwards to the coast the French had built a line of concrete blockhouses, spaced at roughly half-mile intervals along the frontier, mutually supporting and protected by continuous belts of anti-tank obstacle and wire. Road blocks covered all the main road crossings, and in places trenches and smaller pillboxes reinforced the gaps between the blockhouses. Defences in depth there were virtually none.

In anticipation of early attack, the B.E.F. had, therefore, to deploy into position and hurriedly set to work to improve the somewhat meagre defences of the sector we had been given to hold. During the winter two more lines of anti-tank ditch were excavated; many hundreds of concrete pillboxes were built; fire and communication trenches were dug; bridges were prepared for demolition, and roads improved.

By the end of April, despite months of continuous frost and snow,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R. Escaut
Tournai
Courtrai
Ypres
Nieuport
Dunkirk
Calais
Boulogne
Abbeville
Amiens
R. Somme
Arras
Douai
Bapaume
Doullens
La Bassee
Bethune
St Omer

we had prepared a strongly fortified position, 10 to 15 miles in depth, extending for a distance of some 50 miles from Maulde to Bailleul.

So far it had been a Sapper's war.

* * * * *

Meanwhile other formations, which had been mobilized and drafted overseas, had brought the total of first line divisions up to ten. Of them, the 5th (the remaining regular Division), the 42nd (East Lancs.) and the 44th (Home Counties) now constituted 3 Corps: the 48th (South Midland) and the 51st (Highland) had come into 1 and 2 Corps reserve respectively; and the 50th Motorized Division (from Tyne and Teeside) had arrived in a training area south-west of Amiens.

Douai, Phalemphin and Béthune were the Headquarters of the three Corps, and Arras advanced G.H.Q.

* * * * *

Throughout the winter a desultory "smash and grab" warfare had been going on in the south between the French and German outposts facing each other across their common frontier. In November, partly to give our untried troops some taste of active warfare, and partly to enable us to discredit insidious German propaganda (which led the French troops to believe that while they were doing all the fighting, we, the British, were having a peaceful time in the North and enjoying ourselves with their wives and families) we agreed to take over a Brigade Sector of the Maginot Line itself, N.E. of the fortress of Metz.

In the sector which we occupied, the Maginot Line consisted of (*a*) the line of forts proper, permanently manned by specialist troops of the French Army; (*b*) the "Ligne de Recueil," about 5 miles in front of the line of forts, consisting of a series of strong points, protected by anti-tank obstacles and wire, and manned by Units of the Field Army, and (*c*) an outpost position or "Ligne de Contact," five miles or so beyond that again, where the advanced troops looked out from roughly constructed platoon or section posts across deep wooded valleys to the German outposts 1,000 yards away on the crests beyond.

Each Brigade spent a fortnight in the sector, Battalions doing 4-day spells in the two forward lines, and one spell in reserve. In this short time they could do little more than get the "atmosphere" of real war, but, despite the atrocious weather conditions which prevailed throughout January and February, several successful raids into enemy territory brought, to those who executed them, honours and a new confidence in themselves; while in other cases local reverses taught salutary lessons till then unlearnt.

Early in April we agreed to extend our sector and take over a

complete Divisional front. The first Division to occupy the new sector was the 51st, which moved in shortly before the invasion began. Thus it was that the 51st Division was separated from the rest of the B.E.F. during the battle.

In the same month the 5th Division was withdrawn from 3 Corps to be sent to Norway. Only one of its Brigades arrived there. The other two were awaiting embarkation when the final evacuation of Norway began, and they were brought back into the Amiens training area just in time to take part in the advance through Belgium.

On zero day, May 10th, the B.E.F. was disposed as follows :— Deployed along the frontier were 1 Corps on the right with 2nd and 1st Divisions forward and 48th Division in reserve ; 2 Corps in the centre with 3rd and 4th Divisions forward and 50th Division in reserve, and 3 Corps, with 42nd and 44th Divisions, on the left. Two Brigades of the 5th Division were in the Amiens area ; 51st Division in the Saar ; and three " low category " Divisions—the 12th, the 23rd and the 46th—which had been sent out the previous month to solve the labour problem, distributed between the Bases and the Lines of Communication.

* * * * *

The strategic plan—known as the " D " Plan—was as follows. If, and when, the Germans invaded Holland and Belgium, and *if* the Belgians invited us into their country, the French and ourselves were to advance through Belgium and occupy the line of the River Dyle, which runs roughly North and South about 30 miles east of Brussels. The French VII Army, in position between our left and the coast, were to move up into the islands at the mouth of the Escaut and prevent the Germans crossing the estuary. The B.E.F. were to hold the Dyle between Wavre and Louvain, with the French I Army coming up on our right, and the Belgians, whose first line of defence was the Albert Canal away to the north-east, falling back into the gap between our left and the right of the French VII Army.

The apparent weakness of the plan was that, having spent the winter preparing a strong defensive position behind the Belgian frontier, as soon as the flag fell, we were to rush forward and fight the Germans more or less in the open, in an unreconnoitred position. The neutrality of the Belgians had been strictly observed, and we were not able even to have conversations with their General Staff. For our information about the Dyle defences we had, therefore, to rely almost exclusively on reports from our Military Attaché in Brussels. At that time, however, the only alternative—to abandon the Belgians entirely—was not to be thought of, from either the political or the military point of view. Their eleven Divisions, reputedly of good quality, were an important potential asset in view of the disparity in numbers between the Allies and the German Armies facing us.

So, when the invasion began in the early hours of May 10th, orders were issued that the " D " Plan was forthwith to be put into effect. Our cavalry crossed the frontier, advanced through Belgium and pressed on across the Dyle in the direction of the Meuse. Meeting the leading enemy troops they formed a screen with the object of covering the move up and deployment of the rest of the B.E.F.

As we drove through Brussels we were given an encouraging welcome by the thousands of inhabitants who lined the streets to cheer us on. Flowers were thrown into our cars whenever we were forced to slow up. To venture on to the sidewalk was to risk being publicly embraced ! (A sad contrast was our second passage through the city only a week later.) As we drove along the main boulevard the sirens sounded ; a German aeroplane swooped low overhead, and an excited Belgian sentry rushed into the road shouting " Parachutists." But we ignored him and drove on to our Divisional Headquarters in a small convent near Tervueren.

The " D " Plan had been based on the very reasonable assumption that the Germans would take at least a week to ten days to force the crossings of the Meuse. This formidable obstacle was covered by strong defensive works on the near bank, and all its great bridges were ready prepared for demolition. It was expected, therefore, that the battle on the Dyle would begin on or about the fifteenth day. But the Meuse defences, instead of holding out for a week, fell in 24 hours. Through carelessness or treachery several bridges on the French sector of the frontier were left undemolished and the Belgians, stunned by the weight of the German attack, and surprised by airborne troops landed on their forts, failed to hold the Maastricht bridges. Once across the river, the German forces poured through the gaps and began their south-westerly thrust, the main weight of which eventually hit the French on our right.

In front of our positions their advanced elements were reported at Egypte and Tirlemont on the 13th, and the following day—the fourth after zero—our cavalry were withdrawn through the Dyle defences after putting up a gallant running fight which had lasted without intermission for three days and nights.

The move forward to the Dyle had been carried out with remarkable precision and with very much less interference from the enemy than had been anticipated. In spite of the almost inconceivable rapidity of the German advance, all the leading divisions of the B.E.F were deployed and in position by the time the German advanced troops reached the Dyle. Forward, on the river line, were the 2nd, 1st and 3rd Divisions : in support, south and north of Brussels respectively, were the 48th and the 4th : on the Dendre, between Grammont and Ninove, were the two Brigades of the 5th, which had been motored up from Amiens : and back on the Escaut were the 42nd and 44th between Tournai and Audenarde. The 50th

followed closely behind the 5th, taking over the defences of the Dendre and releasing the latter to support the 48th south of Brussels just as the withdrawal began.

All the Dyle bridges were successfully blown ; the river valley—so far as was possible in the exceptionally dry spring—was flooded ; morale was high and all ranks were confident of their ability to hold their ground.

* * * * *

On the front of the 1st Division (to which I had been posted on May 10th), the first night that the Germans faced us across the river, our guns pounded them without ceasing all night long and our infantry easily frustrated attempts by small parties to cross the river the following morning. But from the right, where the 2nd Division were fighting a hard battle, came disturbing reports of an enemy break-through on the front of the French I Army south of Wavre. On the morning of the 16th the Divisional Commander was summoned to a conference at Brussels, at which orders were given for retirement behind the Senne Canal, which runs through the western outskirts of the city. The Dyle line was to be abandoned at 10 o'clock that night and an intermediate line along the road running north and south through the Forêt de Soignies was to be held till morning.

We drove back from the conference *via* the field of Waterloo. In these days of continental warfare it looked a ridiculous setting for one of the decisive battles of history. . . .

Dawn found us snatching an hour's sleep in a large school building on the southern boulevard before moving back to Vlesenbeek, where we established our new Headquarters in a house and farm which were just being vacated by 1 Corps. As he left us, about noon, the Corps Commander promised that orders would be sent us by 4 o'clock that afternoon, but it was nearly 8 in the evening before a wireless message was received by the 5th Division on our right to the effect that the withdrawal was to continue that night. In anticipation of this possibility, our plans were made and orders ready for issue to the Brigade Motor Contact Officers who had been reporting at Headquarters at regular intervals throughout the day. By 10 o'clock we were packed up and on our way back to our next position behind the River Dendre. Division Headquarters were bound for the small village of Steenhuize-Wynhuize, a mile or two west of Ninove. We arrived there at 1 a.m. to find the only suitable building, a large country house, already bespoken by the Field Park Company of a neighbouring division. The C.R.E. had left his Liaison Agent there to act as watch dog. Gently, but quite firmly, he was moved over to a corner of his kennel to make room for larger fry. . . .

There were two reasons for this hurried withdrawal. The break-through on the right was assuming alarming proportions ; the French

I Army was showing no signs of making a stand (their advance to the Dyle had been much slower than ours, as many of their Units were not mechanized); and our right flank was in grave danger of being turned. While, on our other flank, the Belgian Army, instead of carrying out an orderly withdrawal to fill the gap between ourselves and the French VII Army, lost cohesion and could not be reckoned with, at that stage, as an effective fighting force. Our left was consequently, also in danger. The 4th Division had been thrown forward to form a defensive flank to the north between Brussels and Louvain but they were not enough to fill the gap. There was no alternative, therefore, if the greater part of the B.E.F. was not to be sacrificed, but to withdraw.

A retirement of from 30 to 40 miles, from the Dyle to the Dendre, carried out on successive nights, in face of the enemy, with little rest in between, was a severe test for raw troops, and it was a very exhausted army which lined up behind the Dendre during the morning of the 18th—leaving behind them a trail of destruction where the river bridges had been.

Our own divisional sector extended between Grammont and Ninove, each of these places being occupied by a Brigade of the 50th Division.

The 48th Division was now moved to form a defensive flank to the south, and the 5th were withdrawn into G.H.Q. reserve. Farther to the rear "Petre Force" and "Macforce" were being improvised for the defence of Arras and the crossings of the Scarpe east of Douai respectively, in order to prevent the Germans getting round our southern flank.

At dawn, our G1 went off to find Corps Headquarters and collect the latest information. He returned in the early afternoon with the news that a further retirement, to the line of the River Escaut, was to be carried out the following night, as there were still no signs of the French line holding. A breathing space of 36 hours would have given the men some sorely needed rest and the commanders a chance to take stock of their units. But no sooner had our orders been sent out than an urgent message arrived putting forward all the timings for the withdrawal by 12 hours. The effect of this change in timing was that our Brigades had to break off the fight, from close contact, at 10 a.m. the following morning, embus on the main road in full view of the enemy, retire diagonally across the front through the towns of Nederbrakel and Renaix, both of them bottlenecks, cross the the river by Kirkove Bridge, and move down the narrow road running along the left bank of the Escaut, into our new position between the northern outskirts of Tournai and Pecq Bridge. Lorries to carry two out of our three Brigades were being made available, but as these were 30 to 40 miles away in the neighbourhood of Lille, and, to reach us, they had to drive up at night along a road which

was so congested with refugees and other traffic that movement on it had, that afternoon, been virtually impossible, the prospects of their arriving in time seemed none too rosy!

Our plan was that one Brigade should be moved in buses the whole way back to the Escaut. Of the other two, one was to be bussed half way, completing the move on foot, while its buses returned to pick up the third Brigade marching down the road to meet them—the whole operation being covered by an *ad hoc* rearguard consisting of carriers, anti-tank guns and machine guns under the Commander of the Divisional Anti-Tank Regiment.

The day broke fine and clear, and there seemed no reason why the German bombers should not play "merry Hell" with our columns on the road. Miraculously, it seemed, two of the Brigades got safely through. The third, forced to deploy off the road to repel an attack from the south, missed their buses and eventually debouched on to the Tournai road. They arrived at Tournai to find the last of the bridges demolished and were left with no alternative but to drive their carriers and anti-tank guns into the river and scramble across as best they could with the Germans hot on their heels. The German bombers, for reasons best known to themselves, expended most of their hate on the pitiful groups of refugees who had perforce been cleared off the roads into fields by the wayside. Renaix and Nederbrakel remained open and—we got away with it.

Meanwhile the G2 had made his way back by car, on foot, and riding pillion, to Pecq Bridge where he was to meet the Corps representative and receive orders. Realizing the danger, he warned the three Divisional Field Companies which he found in the neighbourhood enjoying a brief rest, that they might have to move in and hold the river line if any of the Brigades failed to get back. Later in the afternoon, therefore, when the leading Infantry Brigade Commander arrived and reported that touch had been lost with the Brigade on the right, the Sappers were ordered into the line, where they once again proved their ability to fight as good an infantry battle as anyone, by holding the right sector for 36 hours until the missing Brigade were able to relieve them. Meanwhile, streaming down the road from Kirkove, through villages which recalled Armistice revels twenty-one years previously, came trucks, carriers, cars, lorries and weary marching Infantry. Against this stream G2 ploughed his way back to find his General and report. Overhead a German aeroplane circled slowly, spraying the column with bullets. . . .

Our new position was in a wide, open valley with the river running through the middle of it, and with little cover for the defenders. A mile and a half away on the German side was the commanding hill of Mont St. Aubert rising sheer out of the plain and completely dominating the position. Nothing less than a Battalion could have held it with any hope of success, and we had none to spare. Since the

start of the battle we had been operating on far wider frontages than those laid down in the text books. Every Battalion had been thrown into the line and now we were a whole Brigade short. Mont St. Aubert had therefore to be left in enemy hands and, with it, observation over the whole of the Escaut valley. Despite this great handicap however, we now made a stand for four days. Gallant, and sometimes costly counter-attacks in the face of heavy machine gun and mortar fire drove party after party of the enemy back across the river and when, at the end of the fourth day, we were ordered to withdraw one more short stage into our original positions behind the Belgian frontier, we still held the river line intact—except for one small group of houses from which the enemy could not be dislodged. Thus, at 10 p.m. on the night of the 22nd we lined up, for the second time, along the Belgian frontier. But not, unfortunately, in our original sectors. This time we were several miles north of our own winter quarters in a strange land which had been the home of the 3rd and 4th Divisions. Frantically we searched for some records of their defensive plan, but none could be found. From l'Hempenpont's bosky acres Division Headquarters was transplanted to Wambrechies on the northern outskirts of Lille, while our Brigades shook themselves out into their new line with the feeling that now, at last, we were going to make a stand.

But away to our rear dreadful things had been happening.

Since the 18th, "Petre Force" (23rd Division, Welch Guards, West Yorks, and a Squadron of Tanks) had been stubbornly defending Arras, to the south west of us, while "Macforce" (127 Infantry Brigade, some elements of the 46th Division, an Army Tank Brigade, and the 1st A.M.P.C.) had been gradually extending their flank along the Scarpe from Raches to La Bassée, as the German thrust penetrated farther and farther into the heart of our position. But Arras had been evacuated on the evening of the 23rd and German A.F.Vs. were attacking Béthune, while, farther to the north, others were seizing bridgeheads on the Aire Canal.

Two days after we arrived at Wambrechies, we were visited by the Corps Commander who told us there had been "trouble on the Lines of Communication" and that we must husband our ammunition. Later that evening came an urgent wire to say that no gun was to fire more than 5 rounds a day. . . .

After that things began to move quickly. On the 24th the 5th and 50th Divisions, which had been held in readiness to co-operate with the expected French counter-stroke by attacking southwards across the gap, were withdrawn from the Scarpe. The former was sent up to Ypres, where the Belgians were now falling back in the face of an attack by eight German Divisions; the latter was brought, first, into G.H.Q. reserve south of Lille, and then sent up to extend the flank of the 5th Division farther to the north. In the west,

Boulogne and Calais had fallen, and the Germans were pressing on along the coast towards Gravelines. To the Staff Officer who was sent over to Corps Headquarters at Armentières to "find out what was happening," the map on the wall told a story from which only one inference could be drawn. Within 24 hours a decision had been taken to save as many as possible of the personnel of the B.E.F. by immediate retirement on Dunkirk—through which was our last remaining contact with the outside world. Surplus personnel and transport were to be sent straight back to assembly areas south of the perimeter formed round the port by the Gravelines—Bergues—Nieuport Canal. All except the fighting vehicles, ambulances, and water carts, were to be dumped in the fields and destroyed, in order that the roads inside the perimeter should be kept clear for the last, critical phase.

The extrication of the force was no easy problem. Those divisions which were facing east had to swing round through a right angle: only one main road was available for each Corps: the initial congestion in the centre area was very great (ten divisions formed up in a gigantic U, all with their tails facing inwards!) and there were enough French troops in the vicinity to make it quite certain that any organized traffic control would be out of the question.

On leaving the suburbs of Lille, we were to share, with the 42nd Division on our right, Houplines bridge over the Lys and the Kemmel—Poperinghe—Rousbrugge road. To cover the withdrawal of the rear parties, one battalion was sent back from each Brigade to occupy the river line on either side of the bridge; but before they had a chance to deploy, a Staff Officer was sent chasing after them to divert them to Messines, where a neighbouring division was being sorely pressed. This meant that the crossing of the Lys had to be effected without a proper covering force—but, again, we got away with it. Brigades were allotted staging areas in the Locre-Kemmel area, in which they were to halt on their way back to the perimeter. Just as the last Brigade arrived in their staging area an attack developed from the west from the direction of Steenvoorde. While one of the other Brigades was deployed to hold off the attack they were ordered to continue their march. When they eventually reached the perimeter, this Brigade, the 3rd, had marched 43 miles in 24 hours!

It is still difficult to understand why we were allowed to reach the coast. As previously stated, one road (and one bridge) was allotted to the whole of 1 Corps of two divisions. Movement control would not, in any case, have been easy. But along it and across it from every direction swarmed the French, with lorries, tanks, guns and horsed transport of all descriptions. The picture we presented must have been a bomber's dream of Heaven! Not that the enemy bombers were inactive. For an hour the writer lay in a ditch (a

muddy ditch) waiting for an opportunity to make a dash through Poperinghe, which was being heavily dive bombed at the time ; and similar incidents occurred elsewhere along the route : but a sustained concentration on any of the main roads must have played terrible havoc. A thunderstorm probably gave us providential and timely protection at a critical moment.

As we drove on through Rousbrugge and Rexpoede, bound for Warhem, our Divisional rendezvous, darkness fell and the dense black pall which hung over Dunkirk changed to a red glow.

By the time we got to our destination it was black night, and we cast round searching for the main village where we hoped to meet other members of the Staff who had gone ahead. Every farm we tried was already occupied—by the French—but eventually we stumbled against friends who directed us to the Corps Headquarters —a dingy room in one corner of the Square. Here the gallant Q Staff were wrestling manfully with G problems, collecting and dispensing such information as was available. One representative of the Division stayed there to await the return of the Staff Captain who had gone to establish contact with the French Command. Meanwhile the floor seemed a good place on which to get a few minutes' sleep. At daybreak the sleeper awoke and set off, with details of the allotted sectors, to drive along the canal road to the bridge at Hondschoote, whence a road ran northwards to Les Moeres. Here he hoped to rejoin the others. This vitally important canal road was blocked from end to end by a column of French horsed vehicles at the head of which stood an Officer studying a map. As I passed him I overheard him say to his companion, " Yes, we must make a plan ! "

The country inside the perimeter was intersected with ditches and small streams and, apart from the one or two roads leading to the coast, it was waterlogged and in danger of flooding. There was little cover except what could be gained from shallow weapon pits dug in the occasional stretches of dry ground. It was this type of country which our depleted Division had to hold for four days and nights while the rest of the B.E.F. were being embarked. One Brigade covered 8,000 yards of front. Most of our Field and Medium guns had been got back but they had an immense area to cover.

We posted an armed guard on Hondschoote Bridge (not so much to stop the Bosche as to prevent the French from driving all their second and third line transport into our sector!) and established Divisional Headquarters in a farm house, with a report centre in an estaminet at Les Moeres cross roads.

Throughout the day—the 28th—the withdrawal behind the canal was completed and we entered upon the last phase. The Divisional Commander arrived back late in the evening, announced his intention of reconnoitring to the coast at 4 a.m. and sent the A.D.C. off

to find him a push bike while he had a few hours' sleep. He was back by 9, and we were ordered to pack up immediately, discard all our non-portable kit, and prepare to march to Bray Dunes. The only road leading to the coast was packed solid with discarded vehicles, and nothing on four wheels had a hope of getting through. It was at this epic moment that our Cipher Officer (a well-known Rugger International) put paid to his bag of tricks with a slab of guncotton, thus removing a great weight from his mind! The 5 miles or so to the coast was one of the most depressing spectacles I have ever seen. Row upon row of trucks, cars, motor cycles and equipment of every description lay literally in heaps. Given time and transport one could have helped oneself to thousands of pounds' worth of loot ranging from razor blades to radio sets. And nothing to be done about it! At the canal crossing south of Bray we elbowed our way through a rabble of Frenchmen and took post at the bridge, where we coaxed and cajoled our allies into moving along to the left while we went right. Our ubiquitous C.R.E. was doing things to the *pont levis* and a Kapok Assault bridge was in temporary use as a substitute.

* * * * *

The embarkation of the force took place from the Mole at Dunkirk and from the beaches to the east of it. 2 Corps embarked from La Panne, a small watering-place about 12 miles away along the coast, 1 Corps went off at Bray Dunes, half-way between La Panne and Dunkirk, and 3 Corps from Malo les Bains on the outskirts of Dunkirk itself.

When we arrived on the Bray Dunes beaches, at about 10 a.m., we found hundreds of men there, lined up and waiting patiently for something to happen. Lying off shore, about a mile away, was a biggish merchant vessel, but between it and us there was a stretch of water which could only be negotiated by boats of shallow draft. Destroyers were cruising up and down but, apart from one whaler which was lying high and dry on the sands, no small craft seemed to be forthcoming—until, on the esplanade, there suddenly appeared a lorry and trailer loaded up with F.B.E.* Our Field Park Company had somehow succeeded in battering their way through to the coast with all their transport and equipment intact, a remarkable feat worthy of recognition. As they drove their lorries down the perilous looking curved ramp on to the beach, we sorted the crowd below into some sort of order before starting a ferry service out to the ship. The operation had its little problems. It was not easy to induce a throng of eager men, each one hoping to be called up to fill a place in the next boat, to stay put, a hundred yards or so away, leaving us a clear space in which to work: nor was it a simple matter to launch

* Floating Bridge Equipment.

flat bottomed boats, loaded up with clumsy British soldiery with negligible knowledge of watermanship, into a shallow sea—particularly with the tide going out. But providentially there was a flat calm and, for the moment, no enemy interference. Sixteen to a boat they went, with four rowing numbers, sworn on oath to bring back the boats after discharging their passengers. Embarkation continued until about 3 in the afternoon when our ship, filled to capacity, sailed away. For the rest of the afternoon we tried in every way we knew to induce another of the many which steamed past to pull up opposite our stretch of coast. But all to no avail. Eight of our loaded boats which had been lying alongside the ship when she sailed, drifted away down the coast and were lost, while, on shore, the men began to wander off in the direction of Malo where ships could be seen lying off opposite 3 Corps beaches. The Bosche started bombing soon after this, and we had to get the men under cover. We assembled all the Officers we could lay hands on and sent them off to collect a hundred men each and bring them back over the esplanade into the dunes behind. Each party, as it arrived, was allotted an area in which to bed down, and told to send one representative to a control centre which we established on a small hillock overlooking the sea front. As soon as it was dusk, after drawing lots to decide the order of their going, we sent them off, at fifteen-minute intervals, to lead their parties along the water's edge into Dunkirk. All went well until a message came through, about midnight, to say that no more ships were coming into Dunkirk that night. (We afterwards heard that a report, presumably of German origin, had reached the Admiralty to the effect that Dunkirk was in flames, and that ships could no longer get into the harbour. I do not know what truth there was in this.)

Our Sappers spent the night putting into running order again many of the derelict lorries lying along the road from Les Moeres. Early on Thursday morning these began to appear on the beach in considerable numbers, and as the tide receded, the Sappers built a pier, running the lorries, about 50 of them, head to tail and ballasted with sandbags, out to sea, and laying decking across their upper works. Thus, when the tide came in we were able to tow the folding boats up to the head of the pier and load them in deep water—a much simpler proposition. Destroyers were now sending motor boats and a Naval Officer came ashore, to act as a link between the Navy and ourselves and to give advice and assistance generally. Once we had the drill taped, we were getting the men away at the rate of a thousand to fifteen hundred an hour. The Bosche again started bombing at 3 in the afternoon but, fortunately for us, he concentrated more on the ships than on the beaches.

By Thursday night, the German guns east of Nieuport had made 2 Corps' beaches at La Panne unworkable. Their piers had been

smashed, and very heavy fire was being concentrated on the town. Orders came that, from dawn on Friday, we were to side step to the left. 2 Corps were to take over our piers, and 1 Corps personnel were to be sent off through the Mole: most of 3 Corps had by this time been embarked. We went out on to the beach at daybreak to see how 2 Corps were faring, and found very little progress being made. Men were pouring on to the beach in thousands, while a fresh wind and a slightly agitated sea was making the pier writhe ominously and adding to the difficulties of launching from the beach. There were ships in plenty but no boats seemed to be getting away. We took charge, and gave them a hand till they had learnt the drill. Proceedings were interrupted for twenty minutes while a gallant Field Company Commander, who had been up to his waist in water for most of two days, delivered an impassioned harangue to a boatload of unhappy Infantrymen who were being towed up the pier, on "the duties of a coxswain!" We got him some breakfast and he felt better! Three-quarters of a mile away, high and dry on the beach lay the burnt-out shell of the old *Golden Eagle*, which in happier times used to ply between London Bridge and Margate. A direct hit on her stern had put her out of the running the previous afternoon and she had been burning all night. We thought she might be used as a pier, but a cursory glance showed that this was out of the question. She had been full of men when she was hit. . . .

By the evening the Bosche had registered our piers, and throughout the night they maintained an accurate and continuous fire which made further embarkation almost impossible. Not more than a hundred men got away during the hours of darkness.

Meanwhile, the Commander-in-Chief had been ordered home, and our own General had assumed command of what still remained of the B.E.F. The latter had, after direct consultation with the Cabinet, arrived at an agreed plan with the French Admiral at Dunkirk whereby the rearguard of the B.E.F. were to be finally evacuated on the Saturday night, June 1st-2nd. The French were to be embarked "50-50" with our troops: all the beaches, and the rest of Dunkirk harbour were at their disposal, and we were to embark from the Mole. The French agreed to hold an intermediate line half way between the canal and the coast, to cover the final withdrawal.

At 5 a.m. on Saturday morning we packed up and moved into Rosendael, where we established Headquarters in a slaughter house. At 10 o'clock General Alexander gave out his orders for the night's operation. Perimeter to be held until 10 p.m.: Brigades holding the eastern sector of the perimeter to make for the coast and march along the water's edge: those on the west to make straight for Dunkirk across country: Commanders and Staffs to see 75% of their troops embarked, then embark themselves.

Throughout a tense day, report after report came in of enemy penetrations at various points along the perimeter—and of desperate counter-attacks. Communications were difficult and, for the first time, we were entirely dependent on wireless. At 9.15 p.m. we moved to a report centre on the front, close to the Casino, which, like every other building within sight, had been reduced to ruins. We established ourselves in the only habitable cellar, and sat down to wait for the first of our troops to arrive. At about 11, one of our officers came in and announced that he had just been on the Mole. There were, according to his account, twenty thousand Frenchmen all over it, in a rather uncertain temper, and there seemed little chance of our getting any men off at all! A moment of horrified silence ensued while we all tried to think of the right answer. The first thing to be done was obviously to stop any more people passing the report centre. So we went out on to the beach and back along the water's edge to meet the Battalions coming from the direction of Bray Dunes. I was actually on my way to investigate a report of a fight which was alleged to be going on between some British troops and a French General when I met the head of the K.S.L.I. marching along the foreshore. In the darkness we could just distinguish the ships which were lying off shore waiting to pick up the French. The latter were making no attempt to use the beaches but were all pouring into Dunkirk. We hailed the boats which were waiting a couple of hundred yards out, to collect their passengers, and diverted the Shropshires into the sea to wade out to them. The Grenadier Guards were just appearing at the report centre from across country, so we tailed them on behind the Shropshires. Shells were now falling fairly regularly, and one landed on a party of Grenadiers as they were crossing the promenade, killing one of their Officers who was very well known and popular in the Division.

By 1.0 a.m., all our people, so far as we could tell, were safely through, and we packed up and set off to drive our two remaining cars through Dunkirk up on to the Mole, and report. Before we had gone fifty yards the second car overturned into a shell crater and had to be abandoned. Its occupants returned to the beach and embarked in one of the ships: the rest of us drove on, over a blazing bridge and along the ramparts to the end of the Mole. Here we found the narrow jetty packed solid with men, and a group of Naval Officers who advised us to try to get the Mole cleared and the men down into cellars or under cover before dawn, as "no more ships were leaving after 3 o'clock!" It was then twenty minutes to 3. The previous night the Bosche had apparently changed his tactics, and, instead of bombing the ships as they lay alongside the quay, he had allowed them to steam out of the harbour and bombed them in the open sea as soon as day broke. Four destroyers and several other ships had been sunk in this way, and the Navy could not risk a repetition. A

chance meeting with a young Dutch Naval Lieutenant led to the offer of a " lift " in his motor launch. " I am going to London," he said, and his words sounded like something out of a fairy tale. Three of us were ordered off by the General, and, at 3.20 a.m. on the 2nd of June we chugged slowly out of that burning horror, heading for the open sea, and Home. . . .

The French stood firm on their covering position, and thus enabled the 2,000 odd who had to remain till the Sunday to be safely embarked before midnight.

A REPLY TO "BARRIER TACTICS."

By CAPT. R. A. BARRON, B.A., R.E.

The opinions expressed in this article are merely those of an argumentative individual and must be accepted as such.

GENERAL.

IT is illuminating to read Major Seeman's article alongside that of Captain Thompson, giving an account of the events at Sedan in May 1940. Many of the points made by the former receive the support of actual occurrence from the latter, and it is, therefore, only fair that a reply to Major Seeman's article should be able to draw on yet another campaign which was denied to him.

Unfairness lies in the fact that Major Seeman, in writing his article before the Russian campaign, was forced to draw his lessons from the sins of "omission," whereas the reply can rely on some support from "commission."

At the same time, the resistance offered by the Russians to the *Panzer* divisions, although magnificent, has not halted them. Can we draw on the Russian Anti-mechanized tactics for lessons omitted by Major Seeman and, possibly, on untried theories for lessons omitted by the Russians?

"Barrier tactics," as a name, brings to mind, far more, the tactics of the defenders of a barrier, whereas Major Seeman, in the greater part of his article, deals with the *strategy* of obstacles. Major Seeman makes little reference to obstacles except in barrier lines but as this reply will lay as much, if not more, stress on the isolated "block," the name *obstacle* is preferable to *barrier*.

Let us then consider the *strategy* of *obstacles*.

THE STRATEGY OF OBSTACLES.

Here we are concerned with the first three sections of Major Seeman's article; his introduction, "The Rear Area plan" and "The Zone of Contact." In his first few paragraphs, he lays down the doctrines on which the strategic lay-out of obstacles must be based and which were all, to some degree, neglected by those countries over which the *Panzer* divisions have trampled. Did Poland, Norway, Holland, Belgium and France extend the use of obstacles to the entire theatre of operations? Poland and Norway barely contrived to make any use of obstacles whatever; the former because her forces were not in place at the right time and the latter because she did not visualize a mechanized land attack. Did not Belgium,

Holland and France fall because a believedly impregnable single " Barrier " line was breached ? Did not all those countries abandon all idea of the offensive ; more particularly the offensive against each individual tank ? One of the major dangers of the heavy constructed obstacle is that it breeds in the soul of its defenders an attitude of " don't irritate the beast."

The Russians have given demonstration of two more essential aspects of the strategy of Anti-Mechanized Defence which Major Seeman does not mention, perhaps because he assumed them ; that the obstacle plan needs support from adequate numbers of fighter aircraft and that the primary object of those obstacles is to delay, or canalize, the advance of the *Panzer* divisions until they can be attacked by Anti-Tank Artillery, whether on the ground or, more particularly, when mounted in *tanks*. Indeed, Major Seeman denies the counter-attack tank to some extent when, under the " Rear Area Plan," he says " The speed and distance with which large armoured forces are now able to strike has made complete dependence upon mobile reserves and counter-attack extremely hazardous." Fighters and tanks are, however, an essential background to the successful operation of any obstacle scheme.

Considering the question of fighter support, it cannot be denied that the Armoured Division depends to a considerable degree not only on the moral effect of its dive-bombers but even more so on assistance from air reconnaissance and air control. Delete as many as half of the aircraft flying over and helping the armoured division and that division is like a boxer with one eye closed. Its focus on the picture of the battle is blurred.

The answer to a bull-terrier in a dog-fight is another bull-terrier and, to the tank, another tank. Given parity in tank numbers on both sides at any one place, we get the tank in its true perspective. A solitary battleship meeting a solitary enemy battleship has been misused. The two will hammer each other while their true prey, the unarmoured and the lesser armoured ships, escape. So too, the tank —and it is the main object of obstacles to bring at least that parity into being, at the time and place selected by the defenders of those obstacles.

Both these essentials, aircraft and tanks, were lacking in the countries which succumbed to the tank, or, if either existed, failed to appear. Captain Thompson tells us that, in the initial stages at Sedan, only occasional French bombers were seen—he makes no mention of fighters—and that the effects of the German dive-bombers were great. He also tells of the German concern at reports of strong French tank units moving towards them.

Let us, therefore, assume that adequate " fighter " support is available and that the numbers of tanks on both sides are approximately equal.

Given these conditions, the attacking armoured division is given another factor to consider—that of protecting its own flanks and rear areas against tank attack. The Germans, after their break through the Ardennes, apparently paid no attention to their flanks but, had the allied attacks south from Douai and north from Arras-Bapaume, ever materialized *with strong tank support*, the Darlans and Lavals of France might still be paying more than lip service to their own country.

Obstacles, therefore, become an ingredient of the offensive as well as of the defensive.

The protection of flanks and rear areas in the offence brings up the question of supplies to the tank formation. Here again the Russians can instruct us. They adopted the "scorched earth" policy whereby nothing which could help the Germans to live on the land was left behind during their retirement. History will tell us how much of the essential supplies used by the *Panzer* divisions in France was drawn from supplies abandoned by the French. Admittedly this policy was made easier for the Russians because of the size of their country, but, whatever the topographical conditions or the type of war in progress, supplies—particularly of petrol—must not be abandoned. This principle is referred to by Major Seeman, with a different objective, as "An outlying zone of destruction."

The stage is now set on which the obstacle lay-out can play its part. Adequate fighters and tanks are available to give the defence striking power; no supplies, other than those carried up its lines of communication, are available to the attacking force and the attacking force must consider the protection of its own flanks and rear areas.

THE OBSTACLE LAY-OUT.

Major Seeman considers "The Rear Area Plan" and "The Zone of Contact" separately. Because of the speed, weight and radius of action of armoured forces, the contact zone may occur progressively at any point between the "front" and the rear of the zone of combat. The obstacle lay-out must, therefore, be identical through the depth of the defence.

It must, as Major Seeman indicates, consist primarily, of continuous lines of obstacles—his "barriers"—both lateral and from front to rear—each of which must be sited and defended as a potential contact zone. Obviously the amount of fire-power available will decrease from front to rear as there must still exist a front against that arm which, once tanks are neutralized, wins battles—the Infantry. On the other hand, as the attack passes through successive barriers its direction is easier to estimate and reserves of Tanks, Anti-Tank Artillery and personnel can accordingly be disposed to

meet it. Between these barrier lines, a cellular pattern of independent zones exists, in any one of which a break through by tank formations can be pocketed. To move forward or laterally, those formations must force the barrier lines.

Carrying obstacle strategy one step further, the cellular pattern of zones must, within themselves, break up, divert and delay enemy tank formations. For this purpose, all roads, railways or other tank routes between and through barrier lines must be blocked at frequent intervals. The " blocks " to fulfil their object must be so sited that there are no immediate détours around them. The attacking tanks must be forced either to attempt the passage of each block or to make détours which, although not of any great length individually, impose delay and the wastage of valuable petrol.

In mobile warfare, the blocks will probably be fewer and concentrated on the protection of focal and vital elements of the obstacle zone and must certainly be hasty. The Anti-Tank Mine supplies the answer. In Static Defence the blocks must be very numerous and may consist of mines, constructed movable obstacles or heavy and massive improvisations depending on the tactical role of the route which they are blocking.

Mines and other explosive blocks will be used on routes essential to the defence for counter-attack or essential communications, constructed movable obstacles on routes which are not operationally essential to the defence but are needed for domestic communications, and massive barriers on roads which are not needed at all.

Major Seeman omits this aspect of the obstacle lay-out but it is essential that the strategic conception of obstacles should include very precise control of the type of block to be erected on any particular route. This applies with equal force to the intentional gaps which must be left in " barrier " lines unless, of course, all intention of re-adopting the counter-offensive has been abandoned.

Every gap or route must be accorded a priority on which the type and degree of obstacles to be used on it, can be decided.

Recapitulating, we now have our static defence area, and to a modified extent the combat area in mobile action, divided by *barriers* into a cellular pattern of independent and tank-proof zones. In each zone, every route and the perimeter of every focal point or vital area, is protected by a series of *blocks*, of types depending on the tactical role of each route.

Barrier Obstacles.

Under his " Rear Area Plan " comes the recommendation by Major Seeman with which disagreement is strongest. He states that " A comprehensive system of prepared demolitions based upon natural terrain lines and ready for instant execution will be the basis for this portion of the barrier plan."

To save construction and because natural obstacles, or improved natural obstacles, are infinitely more effective than their artificial counter-part, the basis of the barrier line must be the natural obstacle. In only one type of natural obstacle, however, is demolition an effective method of closing the gaps and that type is the river line. Demolitions can only create effective obstacles against tanks by creating natural obstacles on detonation; cratering must produce a ditch which a tank cannot cross; a bridge demolition is valueless unless the wet or dry gap, originally spanned by the bridge, is tank proof.

Cratering, depending as it does on the type of soil for its effectiveness, is of very doubtful value as a general producer of tank obstacles and it is a fortunate defence which finds water lines to hand and can rely on bridge demolitions to provide its barrier lines. They may exist laterally or from front to rear in a position but it is extremely improbable that they will be available in both directions.

What artificial means, other than demolition, do exist which can be used to close the gaps in natural obstacle lines?

In static defence which can rely on long periods for preparation, the answer is comparatively easy—Anti-tank mines or fabricated obstacles of steel or concrete, of which the designs are legion. Apart from the almost certain lack of a sufficiency of mines for this purpose, the question of their deterioration under long exposure to weather must be considered. Mines in static defence will be of very much greater value to add depth to constructed obstacles; in the form of fields, closing gaps immediately in rear of likely breaching sites, which may be laid beforehand or while the breaching operations are in progress, or in the form of *blocks*.

In mobile warfare, such as Major Seeman accepts as his basis, the answer is much more difficult. Later in his article he supplies the only possible answer—the Anti-tank Minefield—but, and it is a very big " but," *there will never be enough mines*. Improvisations may supply an answer to a very small percentage of the remaining gaps.

Summarizing, we may say that barriers will be based on the lines containing the longest available lengths of natural obstacles. River lines will be selected whenever possible.

In static defence preparations, the gaps between those natural obstacles will be closed largely by constructed obstacles.

In the offensive or in mobile defence, natural obstacles will again be selected as the basis of the barrier line; even greater use being made of them than in static defence. The most vulnerable or obvious gaps will be closed by anti-tank mines and such improvisations as are possible.

Neither to the attackers nor to the counter-attacking defenders in mobile warfare will much time be available for the preparation of breaching operations, nor indeed for reconnaissance of the opposing

obstacle line. Provided the ground is new to the enemy, reliance can, therefore, be placed on natural terrain to deter the attackers, even if not tank-proof. For example, tank formations are extremely averse to attacking through woods or across streams about which they have no information. Once again we return to the necessity for closing the eyes of the tanks by knocking their aircraft out of the skies.

Under the heading " Barrier Systems," Major Seeman arrives at the same conclusions about the types of obstacle which are of use in mobile warfare or in static defence. He misses one point, however, which is rammed home by Captain Thompson's article on Sedan; that in static and prepared defence as opposed to mobile action, natural obstacles must be definitely tank-proof. " Difficulty " is not a sufficient criterion, as the French found to their cost in their estimate of the Ardennes region. As has been indicated, " Difficulty " may have to be accepted as adequate in mobile warfare, owing to the lack of time and material for extensive preparation.

Types of Artificial Obstacle.

Too many different designs of obstacle exist for a detailed analysis of the function for which each is pre-eminently suitable but it is possible to produce generalizations on the lines of the table which Major Seeman includes under " Barrier Systems."

For *general use*, that is to say in mobile warfare as opposed to siege conditions, the anti-tank minefield is far and away the best obstacle. It has the essential qualities of effectiveness, surprise and speed of erection.

In addition, together with other forms of explosive trap, the anti-tank mine supplies the only obstacle which can be used as a block on roads which must be kept open. It does not form a permanent block on detonation.

Next in the category of general use, come improvisations. Major Seeman includes three classifications between the *mine* and improvisations but, as has been suggested, craters are of doubtful value and log obstacles and *abatis* must be improvisations when speed is the criterion.

Major Seeman omits *demolitions* from his list but the demolition of bridges and culverts undoubtedly supplies a fertile source of obstacles under all conditions of warfare. They are, of course, only of use on roads which are not required by the defence but so, also, are the majority of improvisations.

For *fixed fortifications* we must once again include demolitions both to form barriers and blocks, after which we are left with constructed obstacles.

Under " *The Obstacle Lay-out*," it has been suggested that obstacles

must be divided into categories depending on their speed of erection.

Dealing with *barriers* first, where time is not a consideration, demolitions, anti-tank ditches, or heavy concrete and steel obstacles all provide an answer, in that order of effectiveness.

Next we have the routes which are not needed during the combat but which, it is desirable, should not be closed before battle is joined. The only answers to this requirement are improvisations—heavier and more massive by virtue of the time available for their preparation.

On the routes which are required for domestic communications, until it is essential to close them, a reasonable period—of say half an hour—will be available both for closing and re-opening and use will therefore be made of movable constructed obstacles of steel or concrete.

Lastly, as in mobile action, we are left with the road which is necessary to the counter-offensive and which must be capable of almost instantaneous blocking and re-opening. Once again, the only answer is the mine or explosive obstacle which does not block the road permanently.

Apart from their use in the last category, mines have their greatest value in support of the other categories and as hasty obstacles, which can be laid during action, to block successful breaching operations.

Major Seeman's advocation of wire rolls for *warning missions* raises a difference between our respective terminologies but, on the assumption that the warning mission is directed against armoured fighting vehicles, it is not quite clear how it operates.

Wire rolls—to which our equivalent is the barbed wire concertina —have only a nuisance value against tanks, considerable against some types, less against others, but have stopping power against wheeled vehicles. Possibly the *warning mission* is achieved by dealing with the advanced guards of the tank—the motor cyclist and the armoured car.

Major Seeman gives personnel, mines and chemical agents as the requisites for protection of the obstacles. Apart from anti-tank guns which may be included under " personnel," there are two others which may contribute more to the effectiveness of the obstacle than any of these three—*screens* and *siting*.

Dealing with *siting* first, as the most basic of the two, it must be admitted that the two essential principles are self-evident. The obstacle must be sited to surprise the enemy and there must be no immediate détours around it.

The latter point does not now concern us beyond remarking that it is very frequently neglected. So also is the principle of siting the obstacle so that it is encountered unexpectedly by the attacking

tanks. Whether the attacking formation relies on engineer assault units to clear a path through obstacles or on the tanks themselves to shoot their way through, the shorter the distance during which the obstacle is within view of the enemy, the more delay that obstacle will impose and the less chance there is that the obstacle will be breached.

Turning to screens, we are concerned with an aspect of obstacle protection which may be the deciding factor in defeating the tank. At the end of his section on the *Zone of Contact*, Major Seeman says "Armoured forces fear the anti-tank gun and the anti-tank mine more than any other artificial obstacle." What the tank formation fears more than any weapon or obstacle is the *Unknown*. Imagine a tank commander advancing over close country making all use he can of roads and tracks. In his path, he meets screens of canvas, screens of brushwood or sudden screens of smoke. At each one he must wonder; is the screen defended or is it not? does the screen conceal a genuine obstacle which he cannot cross? does it conceal nothing? Shall he waste valuable ammunition trying to shoot the screen away? They can easily be made almost impervious to any fire he can bring to bear; shall he charge the screen and trust to providence? Providence can be a hard task-master; or shall be turn back and seek a détour? Then the obstacle has beaten him.

Screens are an essential adjunct of every obstacle, explosive, improvised or constructed.

Now, if Major Seeman will forgive us, let us revise his list of obstacles.

For general use:

1. Anti-tank Minefield.
2. Explosive traps.
3. Improvisations } only on routes which can be
4. Bridge Demolitions. } closed.

For Fixed fortifications.

(*a*) On routes needed for defence operations.

1. Anti-tank mines and explosive traps.

(*b*) On routes which are needed for rear-area or non-vital communications.

2. Rails.
3. Steel and concrete shapes.

(*c*) On routes which are not needed once operations begin.

4. Improvisations, interspersed with any of the above.

(*d*) On *barrier* lines.

1. Demolitions.
2. Anti-tank ditches.
3. Concrete and steel barriers.

For warning missions :

Barbed wire concertinas.

For obstacle protection :

1. Siting.
2. Screens.
3. Personnel (including all ground weapons).
4. Mines.
5. Chemical agents.

DEFENCE OF OBSTACLES.

Major Seeman reiterates throughout his article that an undefended obstacle can be expected to cause little more than momentary delay. Does not Captain Thompson tell us that, at 5.35 a.m. on May 10th, 1940, advance German engineer units were *removing* and *bridging over* road blocks in Luxemburg ? As far as there are men and weapons available, every obstacle must be defended. The point cannot be argued, but there will never be sufficient men or weapons. Are we then to construct obstacles only up to the limit of those which can be defended ? Major Seeman under " the Zone of Contact " states that it will rarely be justifiable to do more.

In mobile action, admittedly such as he visualizes, that answer is almost correct but, if we are right in assuming that the counter to the tank can be found, then the mobility of warfare will almost certainly slow down until it becomes static. It is happening now on some sectors of the Russian front and it happened many years ago when the Chinese built an obstacle—a wall—against the Mongol cavalry.

Even in mobile action, screens undefended, but sometimes concealing mines and booby traps, sometimes concealing nothing, will cause more than enough delay and possibly casualties.

Under static conditions, the time and equipment needed to breach a long barrier line, even if partially undefended, will, when added to the delay and expenditure of equipment at subsidiary massive blocks, enable the defending anti-tank artillery and tank formations to move into position for the counter-attack. Provided the formations holding the forward positions, through which the breach has occurred, stand firm and concentrate on divorcing the tanks from their supporting infantry and supplies, the tanks will ultimately be enveloped.

The holding of a large reserve of mobile anti-tank artillery, at any rate in the early stages of the battle, is held to be of greater importance than that every yard of the barrier line or every block should be so defended. There will never be enough guns to go round.

BARRIER TROOPS.

Under this heading Major Seeman suggests the formation of special barrier units suitably equipped and armed both to construct obstacles

and to defend them. While agreeing that a higher degree of co-operation between engineers, artillery and infantry is essential for this type of action than at present pertains, it is not considered that the formation of such units is feasible, or for that matter, desirable.

The unit is only of value in mobile action, and in such action, anti-tank defence calls for too great a fluidity in the dispersal of anti-tank weapons to allow them to be tied down to elements of other arms. The majority of those available to any formation will be held in reserve until the direction of the tank attack can be estimated and, meanwhile, obstacles and barriers will be constructed on the strategic plan. That strategic plan as a whole, is of such vital importance that the control of small units, of the type suggested by Major Seeman, would present an almost insoluble problem.

The success so far achieved by the Germans has been brought about very largely by the high degree of co-operation between the various arms of the Service. That should be the aim in training rather than the formation of specialized units. All experience, so far in this war, has shown that the fewer specialists there are, the better. Engineer units are never left kicking their heels for lack of skilled work and it is not, therefore, desirable that they should be loaded with yet another specialized task. It might be argued that engineers are not essential for the type of unit suggested by Major Seeman, but there are few obstacle sites at which some measure of skilled labour or knowledge could not be used with advantage.

Let us rather train every soldier, of whatever arm, in the elements of anti-mechanized defence. Every unit should be armed with anti-tank weapons or effective substitutes and be capable of laying mines or erecting improvised obstacles and of defending them.

Occasions will undoubtedly arise when it may be advisable to allot a composite team for a specific obstacle task but let the success of that team depend on co-operation rather than specialization.

Conclusions.

With all of Major Seeman's conclusions one must agree, with one or two minor exceptions.

It has been suggested that, if the defence against the tank is successful and if the defence against the counter-attack tank is equally successful, warfare may well return to the static. Under that condition, the use of fabricated obstacles cannot be dismissed. Local improvisations cannot supply some of the essentials for which fabricated obstacles are designed. They are, to a certain extent, limited by the availability of materials and no genuinely effective improvisation is capable of erection *and* dismantling within a matter of minutes—a crucial period in the case of a vast majority of *blocks*.

We must agree that all constructed obstacles are only substitutes

for anti-tank minefields but, once again, the answer is that there will never be enough mines. To no weapon yet devised has an antidote been long in coming. The same is true of the mine and it is undoubtedly true that considerable advantage is gained by the use of obstacles of varied types.

The more different the types of obstacle which confront the tank formations, the more varied the types of equipment which must be carried by the engineer assault units detailed to breach those obstacles. Consequently, the greater delay those obstacles will impose, while the right equipment is brought to the right place.

This raises the question of operations against barriers, with which Major Seeman deals, but it is not intended to argue on that side of the picture as it is a subject to itself. Provided the counter-barrier aspect is considered in the design and lay-out of obstacles, it is as much as can be dealt with in an article of this type.

We must also agree with all that Major Seeman has to say about the defence of obstacles, with the exception of his two deductions that an undefended obstacle is not worth constructing and that special barrier units are necessary. Both these points have already been argued.

The necessity for the increased supply of anti-tank mines cannot be over-emphasized but, above all, do not let us rely exclusively on one weapon to halt the tank. Let us rather work on the lines of bluff; making varied use of mines, booby traps, screens, dummy obstacles or constructed obstacles, in fact, of the *unexpected*. Minefields, unless most carefully concealed, are visible from the air, as are all other constructed obstacles. We must not, therefore, rely exclusively on the minefield, pinning our faith on its faculty for surprise.

Major Seeman's last point about the authority for ordering demolitions arises from the failure of the French in that respect. It is not general practice to do other than rely on the man on the spot to judge the situation and decide whether or not the demolition should be executed.

The arguments are now complete and it remains only to apologize to Major Seeman for any misinterpretations of his suggestions, which may have been made, and to qualify that apology by saying that any argument is usually better than none when broad principles are in question.

The problem that confronts all the reasonable human beings in the world is how to block and destroy the *Panzer* divisions. Every man has his own ideas but even out of such a jumble of theories as this some good may come and ultimately help to remove the reputation of the tank for infallibility.

MUD HUTTING.

By T/Lieut.-Colonel G. K. Cassels, R.E.

1. *Introduction.*—Many of our Officers, recruited in the United Kingdom, are transferred to Africa or Asia, where they find that building materials commonly available at home are extremely scarce. They are told to make the maximum use of local products but discover that the Military Engineering Manuals contain little detailed information to guide them.

Mud has been successfully used for centuries for house building all over the East and so it is hoped that this article, which is based on practical experience, may prove of value to those Eastward bound.

2. *Quality and Moulding of Sun-Dried Bricks* (*S.D.B.*).—In India, S.D.B. can be bought in the market in the same way as Burnt Bricks (*B.B.*), and are moulded just as carefully and of the same earth. In the Sudan the bricks are of a far poorer quality but even so appear to make effective walls. They can be made of any brick earth used locally and are best moulded on the ground near the job. No " frog " is necessary, and a competent moulder with 3 assistants working without a " platter " can make 1,500 bricks a day.

An examination of the first lot of bricks a few hours after moulding will soon show whether or not the soil is suitable. Bricks made of pure black cotton soil do not crack, but are too soft and should never be used. Bricks should be turned up on end as soon as they are dry enough, and must not be built into a wall till 5 to 7 days after moulding. USE OF WET BRICKS MUST ON NO ACCOUNT BE ALLOWED. Suitable bricks will not break if dropped from a height of 4′ on to hard ground. Breakages of S.D.B. are very heavy and, as bonding of the brickwork through the wall is at least as important as with B.B. work, the use of " bats " must be discouraged.

The shrinkage of S.D.B. when drying is not so great as that of B.B., but it is still considerable. As joints are always inclined to be fatter with S.D.B. work than with B.B. work, the breadth of the brick should be less than half the length. If this is not insisted on, the stretchers, with a joint between them, in a 9″ wall, stick out beyond the end of the header bricks, and this is very wasteful of plaster. Experiment proved that moulds $9\frac{1}{2}'' \times 4\frac{1}{2}'' \times 2\frac{1}{2}''$ gave satisfactory results, though the resultant wall is at least $14\frac{1}{2}''$ thick. In any big job it is essential to standardize the mould, or the finished bricks will be found to vary tremendously in size. Contrary to the commonly accepted idea

nothing requires to be added to the brick earth, and in fact very good bricks can be made without straw.

3. *Mud Mortar.*—The choice of the material used for this is perhaps of even greater importance than that of the mix for bricks. Black cotton, or any other soil that tends to crack, is useless. This tendency to crack can be counteracted by adding sand, which may well have to be carted to the site. Though no accurate figures are available, it is certain that good mud mortar has considerable tensile strength.

4. *Foundations.*—The foundations of a building should be based on calculations in the same way as for any other engineering structure but data for such calculations are very seldom forthcoming. Figures of safe earth-bearing stresses measured at one point may be valueless a few yards away, and any scientific designing of foundations will rarely be possible for war-time hutting.

Local builders will generally have arrived at safe dimensions, and it is reasonable to base drawings on these, leaving it to the Engineer on the spot to add depth if unsatisfactory soil is met with. This article deals with single storey buildings only, and for such buildings 1½ brick walls have proved quite suitable, so that foundations are required accordingly.

While the possibility of adapting buildings for civil purposes should certainly be considered when siting, it is seldom that Army huts have much sale value. Extravagance in foundations is therefore unjustified, and in rainless countries like the Sudan, the 6" of P.C. concrete as used in India can be left out altogether. It will be required for walls only if the site is low, or the soil very sandy.

P.W.D. practice in the Sudan calls for a foundation of Burnt Brick 2' deep and 2½ bricks wide. In good quality work, *i.e.*, for Stores, the bricks are laid in P.C. mortar, but for rough work mud mortar is commonly used. Where there are many cracks in the ground, as in "Black Cotton" soil, the depth is increased to a metre (3' 3").

If however a rough building only is required for a year or two, even Burnt Brick is unnecessary, and a somewhat wider wall of Sun-dried Bricks will make a satisfactory foundation. In most cases Burnt Brick has however been specified because the Army continues to require its emergency hutting long after the emergency is over.

5. *Walls up to Plinth.*—As already shown in para. 4 the foundation is nearly always made of Burnt Brick which may well extend up to the plinth. In buildings in which much water is used, the danger of damage to the wall by water percolating down inside is considerable, and this is the most common cause of settlement and cracks.

P.C. plaster will not stick on S.D.B. walls, and in rooms which are frequently washed, such as hospital wards, it is essential to have a

good joint between the floor and the wall, and to have P.C. plaster on the bottom 6" of the wall. It therefore follows that this part of the wall must be of B.B. As there is no object in continuing the B.B. on the outside more than 3" above ground level, the 3 courses above can be made with B.B. on the inside and S.D.B. on the outside, and no springing apart occurs when the wall dries out. A similar economy can be made by having the outside skin only of the foundation courses in B.B., with S.D.B. for the remainder, but this is little better than mud brick throughout.

6. *Walls.*—Bath, shower and ablution rooms must have B.B. walls properly rendered in cement. Cheaper walls are liable to give trouble for this particular purpose. The bonding of these B.B. walls in a vertical line by toothing into S.D.B. walls often results in cracking, and it is therefore better, though not essential, for bath rooms to be built as annexes, away from the main S.D.B. building. The system of " Skins " however, already described in para. 5, is quite satisfactory even in a 9" wall.

Bricklaying for S.D.B. walls follows normal rules but in this rough type of work with somewhat indifferent tradesmen it is unnecessary, and probably impossible, to make them " butter " the sides and ends of the bricks. It is therefore better to insist on each brick being laid ¾" to 1" apart from the next one. Then when the covering layer of mortar is put on, it is easy to work it down into the joints with the edge of the trowel.

The following safety precautions should be insisted on :—

For all S.D.B. Walls.

(1) No portion of any wall should be raised more than 3' in any one day, or more than 3' above any wall with which it joints.
(2) No plaster should be applied for 3 days after the bricks are laid.
(3) Full roof weight should not be added till 3 days after the wall is completed.

Special Proviso for 9" Walls.

(1) No country roofing should be carried by them.
(2) Such walls should not be used to support the weight of scaffolding.
(3) Maximum length between pillars or cross walls should be 10'.
(4) Maximum height should be 8'.

9" S.D.B. walls have been used very successfully for room partitions, screen walls for latrines, compound walls, etc., and can easily support light roofs such as G.C.I.

7. *Rate of Laying Bricks.—M.E. Vol. VII* gives rates for laying

bricks which will not be exceeded in the Sudan but might be so in India. Most contracts contain clauses prohibiting the sub-letting of any part of the contract, but it is certain that most of the S.D.B. building is done by this method.

It is difficult for Engineer Services to use direct labour on big jobs of piece work in this way as payment is by time and not by quantities. If large projects are being done by direct labour, which is not recommended, it will be essential to give task work and to have more than the normal amount of supervision. If work has to be done by direct labour, it has been found best to allow the masons to produce their own assistants.

8. *Plastering.*

Internal.—In India mud plaster is used, while in the Sudan gum and sand plaster takes its place. The latter, if well done, is almost indistinguishable from P.C. plaster though not nearly so durable. It is however even more easily damaged by water than mud plaster, and must never be used where it is likely to get splashed with water.

In work which is required to keep a good appearance, *i.e.*, Messes or Offices, it is better if possible to finish jambs and sills in Burnt Brick, and to render them in P.C. plaster.

A short specification for Gum and Sand Plaster is attached.

External.—In India this work is usually done with cow dung "Lepai" while in the Sudan donkey dung "Zibla" is used. Of the two, "Lepai" is possibly a little smoother. In all this kind of work the best local labour should be obtained. A short specification for "Zibla" is also appended.

In any place where rainfall is considerable, sand plaster treated with cotton seed tar can be used, and this is considerably more durable than "Zibla."

9. *Other types of Mud Walling.*

Pisé Walling.—This is described in *M.E. Vol. VII*, but if carried out exactly in that fashion is almost too slow for war-time hutting. It has been usefully employed in the Sudan for splinter-proof walls up to sill level, 18" being taken as sufficient thickness. The framing bulges outwards when the earth is being rammed and angle iron straps screwed to the boarding were found necessary. A party composed of a mate, 2 carpenters and 2 brickmakers with unskilled assistants worked about a month ahead of the masons, and this resulted in a considerable saving in wages where masons are paid three times as much as coolies. Some time interval is necessary as walls dry slowly.

The consistency of the mud used should be much drier than for ordinary brick earth. A height of 3' 6" can be laid successfully in a day, the wall being tamped in five layers by one or more parties

working round the walls. Using this method, cracks do not go down through the wall, though such cracks do not seem to matter much except on corners. Cracks can be entirely eliminated by the addition of sand, but the resulting mix does not set so hard as purer earth nor is it so impervious to water. The shuttering can be removed after a few hours and erected for the next day's work.

Door jambs, can either be built entirely in B.B., or a few B.B., with holes between for holdfasts, can be laid against the end of the framing. This form of walling can be rammed on top of normal foundations, or over foundations of clay tamped in a trench in the ground. The method employed will depend on the dampness or otherwise of the site.

"Gallous" Walling.—This walling is commonly used for village houses. Foundations are of mud rammed in a trench about 18″×18″, and the wall is built up of 10″ layers thrown on to the course below by hand, no shuttering being used.

This is quite a well paid village job, and it is best to employ the expert, and to let him produce his own assistants. One layer with 6 to 8 assistants can mix and put 10″ a day on a 60′×20′ hut. Up to a height of 6′ a course can be added daily, and from there a course every 3 days up to the roof. If enough buildings are done at once progress is quite fast, and no time is wasted on moulding and drying of S.D.B.

It is usual for the wall to start 16″ to 18″ thick at ground level and to work up with a small batter outside and vertical inside, so that the top thickness is about 12″. Besides the considerable saving of skilled labour in moulding and laying bricks, a further advantage of this method is that earth which cracks when made into bricks, often proves stable enough for mass walling. Quite large cracks, which usually occur under the windows, do not seem to affect the stability of the finished building.

10. *Country Type Mud Roofs.*—Such roofs are in common use in villages and the native parts of towns all over the East. They consist of some kind of strong framing supporting a thick layer of earth protected from rain by an impervious plaster. The roof must be just steep enough to keep water moving readily but not steep enough for the plaster to scour. A slope of 1 to 30 is sufficient in the Sudan, while in India 1 in 20 is used.

There are two types of such roof, one with and one without a parapet. The rafter timber is usually rough and crooked, and, if no parapet is used, some form of barge board or mud stop is desirable to keep the earth in position, but in any case the eaves look very untidy. The roof is usually therefore finished at the wall and a small parapet wall added, which holds the rafters firm, and gives a neater appearance. The ends of the rafters are concealed in the walls, and as no eaves overhang is necessary shorter timber can be used for the

rafters. The flashing between the roof plaster and the parapet walls, and the spout exits, require careful making.

In buildings with two verandahs, or no verandahs at all, it is best to have the roof highest in the centre and to throw water off both sides. Where there is one verandah the roof may well slope away from it.

In ordinary rough hutting no wall plate is necessary, and the rafters, which are usually rough poles diameter 3" to 4", or palm sections, rest in the S.D.B. wall. If the timbers are very crooked it will be essential to nail them to the ridge or centre support so that bends are horizontal. If this is not done timbers tend to turn downwards under load, causing a dip in the roof.

On top of these rafters brushwood, bamboos, or palm fronds are laid, and these must be spaced evenly and tied to distance pieces to prevent movement; every effort should be made to cause these materials to touch every rafter, as any spring in the roof causes cracks in the plaster.

Matting is then laid and must be carefully overlapped, and, in the Sudan, this is covered for protection by a layer of 2" of *Nahl* grass, which resembles hay in appearance. There are various ways of applying the mud, but the best is to cover the grass and matting with a layer of mud plaster, and then to bed a layer of special flat sun-dried earth tiles in the mortar. These tiles are not more than 2" thick and are covered with another layer of mud plaster. When this is sufficiently dry two coats of dung plaster are added, special care being taken to see that there are slopes down to the spout outlets.

In better class work the parapet may be finished off with B.B. on edge in P.C. mortar, but a rounded dung-plastered parapet answers the purpose. A further useful refinement is to have a course of B.B. in cement where the spouts go through the walls, to prevent leaks down inside the walls.

A specification for a good mud roof is attached.

11. *Verandahs.*—As eaves projection is necessary and for the sake of appearance, selected timber should be kept for the verandahs.

No wall plates or brackets are necessary, the rafters can merely rest in a hole in the S.D.B. walls.

12. *Maintenance.*—External maintenance is essential and the rate for plaster work, if not included in the local schedules of rates, can be obtained from the P.W.D. It is usual to give all roofs a coat of plaster before the rains.

13. *White Ant and Beetle Damage.*—Whole books have been written on this subject, and pressure impregnation of timber seems to be the nearest thing to an answer so far evolved. Mud buildings are of

course particularly prone to attack, and considerations of cost will often preclude the use of ant-proof timber.

Time and plant for pressure creosoting will often not be available but the painting of the ends of rafters, and the wall faces of all frames and lintels with coal tar, solignum, or creosote, is certainly a help.

14. *Conclusions.*—Mud hutting is slower than timber, steel or C.G.I. alternatives, and any failures are always due to rushed work. It is for instance impossible to lay any S.D.B. wall at all for about 10 days from the date of start. On the other hand, mud buildings are cool, as well as being reasonably proof against water and dust, and are of great value for war-time use. The importance of consulting the men on the spot, including P.W.D. experts, contractors, and even individual workmen, cannot be over-estimated.

The writer of this article apologizes to any readers who may have reached the end of it, for having omitted to tickle their technical palates by the addition of a single formula.

Specification for Sand and Gum Plaster (Internal).

1. *Sand.*—To be clean, sharp and fine light-coloured sand. If so directed, to be thoroughly washed in fresh water.
2. *Gum.*—To be Arabic of the best local quality.
3. *Mixing.*—The proportion of gum to sand shall be 1 lb. of gum to every 5 gallons of water used in mixing. To be freshly mixed on a clean hard platform (as required for immediate use) to a consistency required for good working. Any plaster which has commenced to set is to be removed from the banker and discarded.
4. *Plastering.*—Walls to be thoroughly brushed down and cleaned and free from dust, mud and cement. If so directed, the joints shall be raked out and the face of walls hacked to form a sufficient key. Plaster to be applied to a thickness of 2 cm. All angles to be carried up straight and true, arrises finished square, splayed or rounded as required. Surface to be finished smooth and free from trowel marks.

Specification for Zibla Plaster (External).

1. Zibla to be of good quality well fermented "donkey" Zibla. To be composed of donkey manure and fine dust in the proportion of three parts of manure to one of dust. Dust to be free from earthy soil.
2. Zibla should be thoroughly well mixed dry, then well watered, banked and allowed to mature for a period of five days, after which it should be well watered and puddled to the consistency of thick cream before being applied over surfaces, to proper falls, to a thickness of 5 millimetres.

3. The Contractor must on no account exceed the correct period for fermentation as laid down by the local Sanitary Authorities and will be responsible to the C.R.E. that these conditions are complied with.
4. The Contractor will not be allowed to mature Zibla at the site of the works but shall mix and mature the Zibla for the whole of the work at a site to be selected and pointed out to him by the Supervising Officer.
5. Matured Zibla brought on to the site must be incorporated in the work within 48 hours. If Zibla is left for a longer period, it shall be caused to be removed off the site and dumped as rubbish, and no claim for compensation for such removal shall lie against the War Department.
6. Existing Zibla to be removed where either cracked, scaling, disintegrated or of excessive thickness, where two coats of new work will necessarily be applied. Debris to be removed off the site.
7. Any depressions or inaccuracies in levels and falls are to be daubed out with Zibla before the first coat is applied.
8. *One Coat Work.*—All external faces of walls to be thoroughly cleaned down and damped before the plaster is applied. The plaster to be applied in one coat not exceeding 5 millimetres. Surface to be left clean and free from trowel marks.
9. *Two Coat Work.*—First coat to be applied to a thickness of 3 millimetres and allowed to dry thoroughly before the second coat, also 3 millimetres thick, is applied. Surface to be left clean and free from trowel marks.
10. All debris and rubbish to be carted away, splashes to faces of walls, etc., to be cleaned off, depressions in ground where mixing has taken place to be filled in and left clean on completion.

SPECIFICATION FOR NATIVE TYPE ROOF.

To consist of 4″ dia. poles, or split palm logs fixed as rafters at 40 cm. centres. A layer of sound brushwood or "palm frond" placed side by side and properly tied so as to form a regular mat, secured to rafters with 1″ native rope. A layer of good quality matting laid over the brushwood with 6″ side and 9″ end laps and secured to rafters with native rope. A layer of not less than 3″ of good quality dry grass laid evenly over the matting. A layer of not less than 1½″ of mud spread evenly over the whole roof. A layer of mud bricquettes laid to required slope and properly jointed with mud plaster, and two coats of well fermented donkey Zibla over the whole roof. To be left with a clean and even surface.

ENGINEERS IN BATTLE.

By CAPTAIN PAUL W. THOMPSON, *Corps of Engineers, U.S.A.*

(Reprinted from *The Military Engineer* (Washington), July-August, 1941.)

RIVER-CROSSING OPERATION.

*Engineers in Action over the Upper Rhine (Colmar).**

AMONG dozens of actions in which German Engineer units distinguished themselves during the campaigns of 1940, there were two which are especially noteworthy: the reduction of Fort Eben-Emael on the first days of the invasion; and, the crossing of the Upper Rhine near Colmar on June 15th and the days following. Both of these actions illustrate brilliantly the fine co-ordination of arms which characterizes German tactics, both of them illustrate brilliantly the part played by Engineers in the German combat team.

This is the story of the Colmar operation. The story is included in this series at this time with some reluctance, because the operation in question deserves a much more exhaustive treatment than the incomplete data now at hand permit. However, it may be a long time before full information is available; and so, we shall risk this almost superficial account of an audacious enterprise which in the future is sure to occupy many a page of this and other military magazines.

From the German point of view, the general situation on June 15th, 1940, was about as follows: the group of armies on the extreme right wing (Army Group B) had forced the Somme and the Lower Seine, and had taken Paris (on June 15th). The centre group of armies (Army Group A), making the main effort and attacking with mechanized and motorized division, had forced the Aisne (on June 9-10th) and was pursuing the French forces toward the Swiss border. The one menace to this main German effort arose from the possibility of a flank attack by the three French armies located in and behind the Maginot Line in Alsace and Lorraine. In order to neutralize this menace, the Germans planned a series of "holding attacks" against the Alsace-Lorraine fronts. One of the holding attacks was to be made by the First Army, attacking south from the vicinity of Saarbrücken. The other holding attack was to be made by the Seventh Army, attacking across the Rhine River in the

* From various accounts, chiefly one in *Militarwissenschaftliche Rundschau*, January, 1941.

vicinity of Colmar. It is with certain phases of the latter operation that this account has to do.

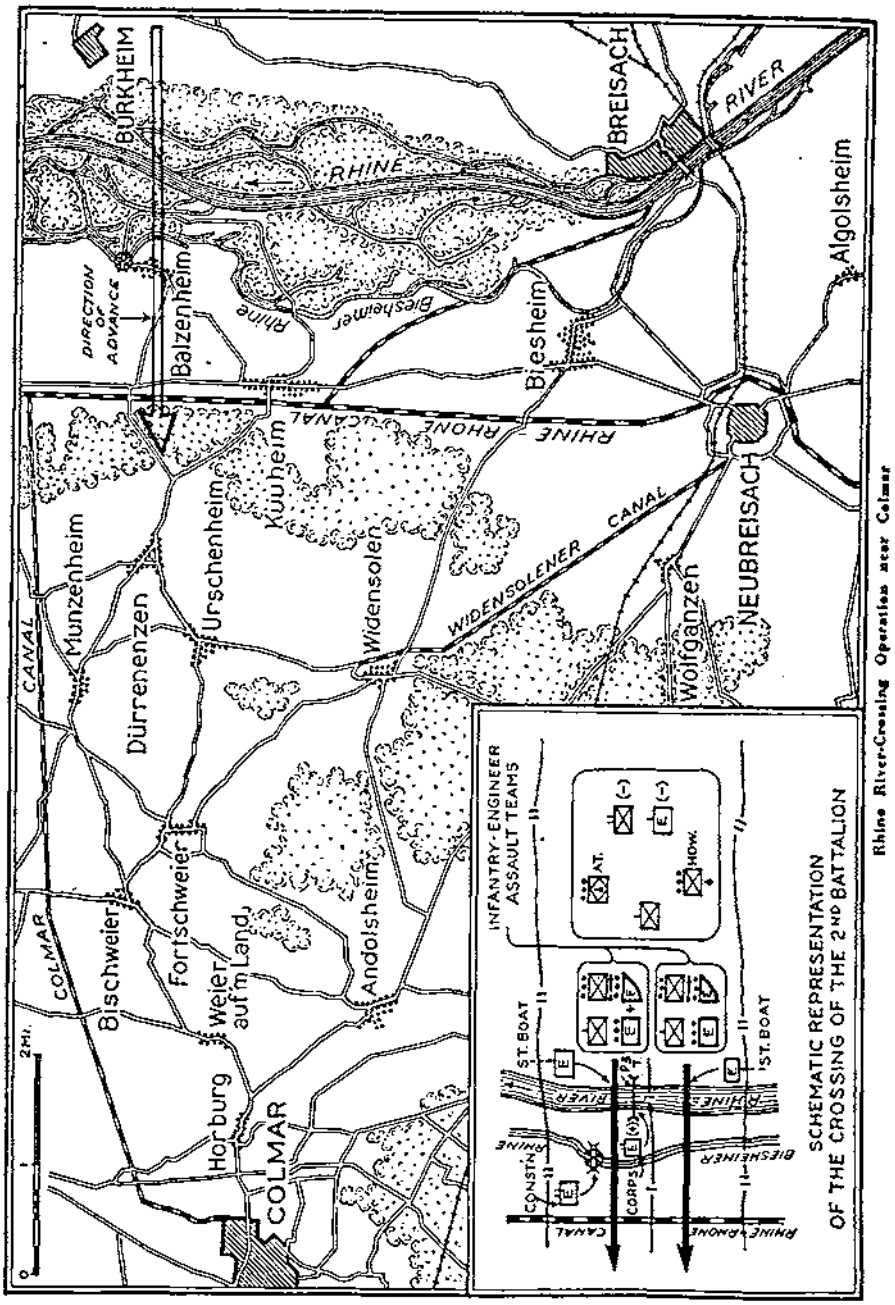
The Germans refer to the Colmar operation as a breaking of the Maginot Line. However, so far as fortifications are concerned, the main Maginot Line extended only along that part of the French-German border not protected by the Rhine River. South of the main portion of the Maginot Line the French fortifications were less formidable. Along the river bank there was a line of concrete emplacements, designed chiefly for the purpose of holding the river itself under interlocking bands of machine-gun fire. These emplacements were tied into a system of field fortifications, the latter including trenches to be manned by riflemen. Farther to the rear, there was another line of French emplacements, in general along the Rhine-Rhone Canal. Still farther to the west were the Vosges Mountains. So far as can be determined, there were none of the great works usually associated with the phrase " Maginot Line " in the sector near Colmar. It seems clear that in this zone, at least, the French were depending heavily upon the Rhine River for their security.

The Rhine River near Colmar is about 250 yards wide, and has a current in excess of 12 feet per second. As indicated on the map, to the west of the Rhine itself there are two other smaller waterways : the Biesheimer-Rhine, an old channel of the main river ; and, the Rhine-Rhone Canal. The terrain between the Rhine and the mountains is flat, and is wooded to an extent as shown on the map. Certainly few will question the French conclusion that the Rhine near Colmar was such a formidable obstacle as to justify the weaker fortifications behind it.

An accurate estimate of the forces opposing the Germans near Colmar must await the availability of further information. It is certain that a large portion of the French reserves had been drawn off to the northern fronts before the attack of June 15th. The regular fortress troops apparently were occupying the fortifications and other positions in normal strength ; but, it may be assumed that their morale, which never was very high, was scraping bottom by the time the attack came. As evidence of this fact, one needs only to recall that as the Colmar attack began, Paris was falling, the French armies everywhere were in disorganized retreat, and the Maginot Line itself already was facing isolation from the remainder of France.

This absence of strong enemy resistance, and especially the absence of enemy counter-attacking power, no doubt will keep the Colmar operation from ranking among the great river crossings of history. Nonetheless, the technique used by the attackers will remain a fruitful subject for study.

The time for the jump-off for the attack was set for 10 a.m., June 15th. Here we see, right at the start, a break with Field Service Regulations, which would have such an attack begin at no other time



Rhine River-Crossing Operation near Colmar

than dawn. The reasons for the selection of mid-morning as a jump-off time are not completely clear, but probably it was a means of securing surprise. The decision as to time of attack must have been based on careful observation of the habits of the defenders. It seems that the French were highly alert during the night and up through dawn (it is recorded that, on the night preceding the attack, every slight noise on the German side brought forth a hail of fire from the opposite bank); but they were accustomed to taking things easy during the remainder of the day. The Germans must have decided to capitalize on this state of affairs (as a matter of fact, the first wave of assault troops caught some of the defenders just getting out of bed, whence they had gone to pick up a little extra rest after breakfast).

From this point on, a considerable part of our account will concern the operations of one " II Bataillons IR 444," which we will refer to simply as the 2nd Battalion, 444th Infantry. The 444th Infantry was one of the Division's assault units. It was to attack with battalions abreast, 1st Battalion on the left, 2nd Battalion on the right. The 2nd Battalion was to assemble in a previously-reconnoitred area southwest of Burkheim during the night of June 14th. The objectives of the battalion are indicated on the map.

The 2nd Battalion was a normal German Infantry unit and so consisted of three rifle companies (E, F, G) and one machine-gun company (H). For the river-crossing operation, there were attached to the battalion units as follows:

1 company of Engineers (three platoons) apparently from the Divisional Engineer Battalion.
1 platoon of infantry howitzers (2, 75-mm. pieces), from the Regimental Howitzer Company; and
1 platoon of anti-tank guns (4, 37-mm. pieces), from the Regimental Anti-tank Company.

The attachment order provided that the Engineer Company was to remain with the battalion only until the Rhine-Rhone Canal had been crossed. The other attachments were to function until further orders.

The 2nd Battalion attacked with two companies abreast, F Company on the right, G Company on the left. To each assault company, were attached units as follows:

1½ platoons of the Engineer Company; and 1 platoon of machine guns (4 guns) from Company H.

Company E was in battalion reserve, with orders to follow the advance behind the centre of the two assault companies. The howitzer and anti-tank platoons and the remaining machine-gun platoon, were in general support, under direct orders of the battalion

commander. Apparently the Engineer Company Commander and his headquarters moved with battalion headquarters

In the German Army, the strength and organization of the Engineer Company do not differ greatly from those of the Infantry company. Thus, we see that almost 30 per cent of the strength of the small combat team built around the Infantry Company was composed of Engineers.

The night of June 14-15th was dark and rainy. Working under difficult conditions, the Engineers spent the night cutting and

Storm Boat Loaded with an Assault Detachment Crossing the Rhine.

marking paths down to the crossing points. Due chiefly to the rain, the assembly of the companies of the 2nd Battalion was delayed, one of them not arriving until 6 a.m. As the companies arrived, the troops were assigned to crossing points and waves, and were guided by the Engineers to the proper areas.

While these preparations were in progress, the " storm boats " which were to be used for the crossing of the initial waves were being moved forward toward the crossing points. This brings us to one of the most significant phases of the entire operation.

The German " storm boat " (*Sturmboot* or *Blitzboot*) is illustrated in the accompanying picture. The boat apparently is made of lightweight metal (possibly of plywood) and is powered by an outboard motor which appears to have four cylinders and which probably develops upwards of 40 h.p. The motor with its long propellor shaft serves also as a rudder for steering the boat. An idea as to the weight of the equipage is gained from a sketch (not reproduced here) which

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shows six men carrying the boat while four men carry the motor. The capacity of the storm boat appears to be eight men with personal equipment, and the crew. The crew consists of a single Engineer soldier. The storm boat is one of the very few items of German Engineer equipment which had not been observed in use prior to the war. It is likely that it was developed especially for the crossing of the Rhine.

It appears that the storm boat is found only in special " storm boat companies." These special companies not only transport and maintain the boats ; they operate them as well. The exact allotment of storm boats for the operation under discussion is not known. There is mention of there having been thirty of the boats moving over a narrow front ; but whether this represents a company front or the battalion front is uncertain. There is further uncertainty as to whether or not the storm boats were operating directly under the orders of the commander of the 2nd Battalion. It seems that such was not the case.

Summarizing, the crossing operation itself was to proceed about as follows : each assault combat team (company of infantry, half-company of Engineers, attached machine guns) was to be set across the river in storm boats, the latter being operated by personnel of the storm boat company. The Engineers with the assault companies thus were not to figure in the actual ferrying of the initial waves. Rather, they were to constitute a part of the initial waves themselves.

The German troops in their assembly areas spent a wet and uncomfortable night and morning. They were soaked to the skin. While they waited, " . . . the last preparations painstakingly were made. Once again, the leaders of the storm boat units explained to the troops of the initial waves exactly how they should handle themselves in the boats. . . ."

At exactly 10 a.m. (June 15th) the German artillery opened up. There is little information on the characteristics of this preparatory fire—except in one interesting particular. Flat trajectory, high velocity guns (anti-air and anti-tank), which apparently had been brought close to the river bank during the night, took the emplacements on the French bank under fire at point-blank ranges. Firing armour-piercing projectiles and aiming for the ports, this fire was highly effective.

At 10.10 a.m. the preparatory fire lifted and the storm boats were pushed into the water. By this time, the rain had subsided and visibility over the river was fair. The Germans continued to deliver covering fire from their own emplacements as the storm boats pushed off on the 20-second trip across the river. The French in their forward position had been taken completely by surprise ; and they apparently had been stunned by the terrific 10-minute preparatory bombardment. Due to this bombardment, most of the French

emplacements had been put out of action. Since machine-gun fire from these emplacements must have been the key factor in the close-in defence of the river, the significance of that bombardment is obvious.

Through this and other phases of the crossing operation there is no mention of any considerable French artillery fire. The lack of such fire poses questions which cannot be answered with the information at hand.

Although no wall of machine-gun fire such as the French must have planned met the German assault waves on the river, still the attackers suffered serious losses. Most of these resulted from fire coming either from sharpshooters in the trees or from riflemen in field positions. There is a note to the effect that the point-blank preparatory fire which had been so effective against the emplacements was much less effective against the sandbagged field positions. In any event, " . . . soon more than one-half of the storm boats had been put out of action, some of them because of motor failure. . . ."

Immediately after reaching the far bank, the Germans proceeded to complete the reduction of the forward French line of emplacements. In this operation " . . . the resistance of the enemy was broken by the *co-ordinated attack of Infantry and Engineers.*" Thus, again we have the picture of Engineers having been included in a small combat team, not for the purpose of the crossing operation itself, but for the subsequent assault of enemy fortifications.

In this assault, the Engineers must have used the technique, the essence of which is the application of Engineer explosives to the fortifications themselves. As a matter of fact, the assault boat shown in the accompanying sketch is transporting what appears to be an assault detachment composed at least partly of Engineers (as evidenced by the long charge-placing poles). The picture indeed is interesting : *assault* Engineers being set across a river by *storm boat* Engineers.

The progress of the 2nd Battalion after overcoming the resistance of the French forward line may best be followed on the map. The first crisis arose as the assault units approached the Biesheimer-Rhine, which as has been indicated, is a narrow arm of the main river. The Engineer Company Commander was sent forward to reconnoitre the situation ; and he returned with the report that the stream was too deep to be waded, while the banks were too soft to permit use of pneumatic boats. Further reconnaissance developed a ford north of Balzenheim, near the site of a bridge which had been demolished by the French. Infantry and Engineers pushed across the ford and succeeded in establishing there a shallow bridgehead. Considerable trouble was occasioned by sharpshooter fire from the village of Balzenheim. Apparently the entire battalion used this ford during the afternoon.

Just above we have the first mention of that well-known article, the German pneumatic boat. The pneumatic boats had not figured at all in the initial crossing of the Rhine, and as has been indicated, they were not suitable for use on the Biesheimer-Rhine. The interesting point now, however, is the manner in which the pneumatic boats were being brought forward. They were being carried by E Company, the reserve company of the battalion. Here we have another interesting picture : Engineer units forward with the assault Infantry ; floating equipment a short distance back being carried by reserve Infantry.

The crossing of the Biesheimer-Rhine was completed by about 8.30 p.m. The battalion thereupon took up a bivouac position with both flanks bent back on the stream. The crossing had succeeded, but, " . . . rations had not come forward, and, above all, good drinking water was lacking. . . ."

About 9 p.m. the French positions along the Rhine-Rhone Canal, just ahead of the 2nd Battalion, were subjected to a dive bomber attack. This is the first mention of any air support in the Colmar operation. About the same time, a " platoon of light artillery " and the howitzer platoon attached to the battalion came up, and " . . . secured the bridgehead of the battalion through fire on the village of Balzenheim."

This mention of artillery support (9 p.m., June 15th) indicates that vehicular ferry operations had been proceeding over the Rhine. Actually, large-scale bridging operations were already in progress, probably by Corps Engineer battalions especially assembled for the purpose.

Details relative to the bridge construction operations are lacking, but there is a note to the effect that " . . . the most difficult part (of the bridge construction operations) was the guiding into place of the individual rafts which made up the bridge. This phase of construction was begun on the second day." That would have been on June 16th. As has been indicated, vehicular ferries must have been in operation during the afternoon of the 15th.

Consideration of the characteristics of the Rhine confirms the German comments as to the difficulty of constructing the bridge. The swift current precluded the handling of rafts by anything other than motor-boat power. The swift current combined with the gravelly character of the river bottom made the functioning of the anchors uncertain. The former difficulty was overcome through use of the standard German 100 h.p. motor-boat : the latter, through resort to the device of attaching lengths of heavy chain to the anchors. There is an uncertain note to the effect that the bridge was completed at 9.30 p.m., June 16th. If so, it was a performance for the books.

Meanwhile, during the night of June 15-16th, still another type of Engineer unit had entered the picture. This was a " construction

battalion," pushed forward to rebuild the bridge at Balzenheim which had been demolished by the French.

Thus, on the morning of the 16th, we see Engineer units as follows in action through this particular sector of the Colmar operation: the combat company far forward with the assault infantry; a construction battalion setting up the trestle bridge at Balzenheim; the storm boat Engineers, resting from their exploits and awaiting the Iron Crosses which each of them received; and, the Corps Engineers operating the ferries and building the bridge back near Burkheim.

On the morning of the 16th, the 2nd Battalion sent reconnaissance detachments out toward the Rhine-Rhone Canal. These came back to report: (*a*) over the area there were many obstacles, mostly of barbed wire; and, (*b*) the French had abandoned the forward emplacements but were holding others behind wire obstacles, this side of the canal.

At 10.20 a.m. there came an order from the regiment: "Dive bomber attack, at 11 a.m. last bomb attack. Division attacks to Rhine-Rhone Canal. Artillery supports attack." A few minutes later, the battalion commander issued his order:

Time and Date: 10.30 a.m., June 16th, 1940.

1. Dive bomber attack ends at 11 a.m. At 11.01 a.m. we attack toward the Rhine-Rhone Canal.
2. Formation: Same as yesterday: F Company right, G Company left; E Company carrying pneumatic boats in battalion reserve following assault companies. Attached Engineers and machine-gun platoons remain with companies to which attached. Third platoon, H Company (machine guns) remains at battalion disposal following behind G Company.
3. In case of shortage of ammunition, supplies to be renewed by reserve company.
4. After crossing the canal, battalion assembles on the road Durrenenzen-Urschenheim, prepared to march to the south.

At 10.01 a.m. the assault companies jumped off. Details are lacking, but we do have here a brief note as to the type of resistance encountered by one of the assault companies (G Company). In the zone of advance of this company, there were two concrete emplacements, connected by a system of trenches. These emplacements were overcome in due course and at 12.10 p.m. the company was on the banks of the canal. At 12.30 p.m. the other assault company came up. Apparently, there now was little resistance, since some troops made the crossing in boats which they found tied along the banks. Within a few minutes, the reserve company had come up with the pneumatic boats and the crossing was completed.

On the far bank of the canal the battalion ran into a dump of French provisions. This was considered a great piece of good fortune, inasmuch as the German rations still had not come forward.

Resistance now apparently was at an end. During the afternoon of the 17th, the battalion assembled on the road and apparently in route column headed south along the Rhine Valley in the direction of Belfort. The order of march was: G Company, F Company, Engineer Company, E Company. Whether or not E Company still was carrying the pneumatic boats is not on record.

MINE-LAYING OPERATIONS.*

During the autumn of 1939, highly disturbing reports from the Saar front began to reach French G.H.Q. The reports told of French detachments being decimated, or even wiped out, by mysterious blasts encountered in woods, fields and villages. The French concluded that the Germans were using a new type of mine, and urgent instructions went out that specimens of the new mine must be obtained. Ultimately, specimens were obtained, and French counterparts of the mine were designed: but that is another story. Meanwhile, the soldiers at the front had found a descriptive name for this new menace to their security and morale. They called the new mine the "*silent soldier*." More about it later.

This little note on the silent soldier is by way of introducing the subject of the remarkable mine-laying operations of certain German Engineer units during the eight-month pre-*blitz* phase of the war in the West. During those eight months, the Germans and the French were in direct contact only along the Lorraine-Saar front. The general situation was one of super-stabilization. The respective main forces were installed in their great permanent fortifications, and neither force had any serious intention of attacking the fortifications of the other. That was the general situation; but, it encompassed a number of special situations in which advance elements of the main forces engaged in small-scale offensives and counter-offensives over the miles-wide area, between the fortified lines. It was all a little absurd, and gave rise to the phrase "phony war." However, to anyone within 30 or 40 yards of the explosion, there was nothing "phony" about, say, the silent soldier.

Information on the subject is by no means complete; but, it appears that the German plan during those early months of the war was to make any French advance first pass through extensive mine fields. In general, the fields were laid well out in front, and were *not* covered by fire. However, the mines were painstakingly camouflaged, and there were literally thousands of them for every mile of front. The idea was that passage through the mine fields would slow down the French advance, would result in extensive casualties, and would affect the morale of the attackers. The German execution of

* From an account in *Vierteljahreshefte fur Pioniere*, 3rd Quarter, 1940.

this plan probably constitutes the greatest programme of mine-laying ever to have been undertaken.

In general, two types of mines figured in the German operations. First, there was the silent soldier, already mentioned. The Germans called this their " *S*-mine " (*S* for *Shrapnel ?*). It was designed for effect on personnel, and it secured that effect through use of a kind of shrapnel. The second type of mine was the standard German anti-tank mine. They called it the " *T*-mine " (*T* for *Teller*). It was disc-shaped, weighed about 22 pounds, and carried a charge of about 11 pounds. It was designed for effect against tanks and other vehicles.

In addition to their standard types of mines, the Germans made extensive use of booby traps. If the French occupied a village or a set of farm buildings which had been exposed to the enemy, it was like having a tiger by the tail. No knob could be turned, no window raised, no door closed, no chair sat in, no drawer opened, no object lifted, except at the risk of setting off a booby charge.

In the German Army, the handling of mines and explosives is essentially a function of Engineers. For the special mine-laying operations on the Saar front, it appears that Engineer battalions from the Corps and Army were used. Apparently, the units assigned to the mine-laying missions had had no special training (since the first thing they had to do on reaching the front was to " familiarize every man with the various types of mines "). It seems apparent that the Engineers were distributed on the basis of about one company per regimental sector.

From this point on, these notes will concern chiefly the activities of " 3/Pi. 252." The reference is to the 3rd Company of the 252nd Engineer Battalion—a reference which we hereby simplify into a plain " Company C." Company C, then, arrived on the western front in October, fresh from the campaign in Poland. It was attached to a regiment holding a sector along the Blies River in the area where that river forms the border between Germany and France. It happened that, as Company C arrived, the regiment had just carried out a successful counter-offensive, throwing back a French force which shortly before had penetrated into Germany. As a result, the regiment now found itself hemmed in by its own minefields, laid months before. The situation was complicated by mines which the French had laid during their occupation of the area.

Thus, the first mission given Company C was to delineate the existing minefields, to mark the limits of the fields plainly, and to clear and mark passages through the fields. The experiences of Company C in accomplishing this mission give us a chance to enunciate what the Germans consider to be the Number 1 principle of deliberate mine-laying operations: *there must be an accurate plan of every minefield.* In the case confronting Company C, there was no such plan. The mines had been laid hurriedly by another company

which was now far away. The area "had to be searched, bit by bit."

In clearing a field of mines, the Germans were especially cautious when there was a chance of *S*-mines being around. The search for *S*-mines was made by parties of two, with intervals of 100 yards between parties. When a mine (*S* or *T* or French) was located, the news was passed around, and all men not actually at work removing the mine hugged the ground until the removal had been completed.

The deadliness of the *S*-mine is emphasized again and again in the

German Mine Detector in Operation.

German accounts. For example, there is an account of an instance in which a party of four Engineer soldiers tripped over the trigger wire of an *S*-mine which had escaped the attentions of the clearing parties. All four men were killed instantly. It seems clear that anyone who has thought of mines as being effective chiefly against vehicles must revise his opinions. The mine warfare of the Germans along the Saar during the period of stabilization was directed chiefly against personnel and only incidentally against vehicles.

Parenthetically, it may be noted that the Germans have devices to detect buried mines. There is no evidence that such devices were used in the mine-clearing operations along the Saar front; but, as a matter of interest, a sketch of one German mine detector is presented here. The device operates on an electro-magnetic circuit in

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such manner as to register on the dials when the detector passes over a mass of metal. The operator of the machine marks the spot in question, the clearing party follows up, digs up the mine, and disarms and removes it. Meanwhile, the wheels of the detector leave white lines along their tracks, so that the area searched is automatically outlined.

The French also had a special type of mine detector. This consisted of herds of cattle and pigs, which were driven across the areas suspected of being sown with *S*-mines. The Germans state that reoccupied minefields always were heavy with the odour of decaying cattle and pig flesh ; but the French apparently had little confidence in their method. In any event, before advancing across any terrain where the Germans were likely to have been active, the French called on their own Engineers to go ahead and on hands and knees, to search every inch of the ground.

Even before it had finished the job of delineating and clearing away the old minefields, Company C was engaged in the laying of new fields. The new minefields were to serve for the new regimental positions just as the old ones had served for the original positions. The fields were to be laid far to the front, beyond the outpost line, and they were to extend in great depth back to and through the forward German positions. " No road or path which could be used for supply was to be overlooked. No terrain suitable for tanks was to remain unmined." As for personnel, *S*-mines were to be laid " . . . in all likely assembly areas and along all routes of approach . . . and in all hidden corners where foot soldiers might seek shelter. . . ."

The first step in the actual laying of a field was the surveying operation. The company survey detachment would go forward " . . . equipped with tape measure, clinometer, compass, marking rods," and would lay out the field, tying it into some reference mark which " . . . neither artillery fire nor other hazards of battle could destroy." The mines then would be brought forward and stacked in dumps. Carrying details (one man carrying two mines) transported the mines from the dumps to the place of use. If the field was out of sight or range of the enemy, the actual laying of the mines was a simple daylight operation. If the contrary was true, the work had to be done at night, and silently. It appears that many fields were laid at night under the very noses of the French, allegedly without the latter being any the wiser.

Unfortunately, we have no data as to the dimensions or other characteristics of the fields themselves. However, in the German accounts, great stress is laid on the fact that the fields invariably were laid in great depth. This was always a matter of surprise to the French, who considered mines as anti-tank devices, to be laid in narrow bands immediately in front of the position, where they could be covered with fire.

Lacking details, we may obtain some idea as to the extent of Company C's operations by a glance at some all-inclusive statistics. There is mention of a single anti-tank field, laid in the open terrain, which contained 1,296 *T*-mines. This field apparently was 54 rows deep. Then, there is mention of the fact that, by April of 1940, Company C had laid in front of its regimental sector a total of 227 minefields of various types. In these fields there was a total of about 6,000 *T*-mines, and about 1,700 *S*-mines. That many mines again lay in the Company dumps, " ready for quick use in areas for which surveys already existed."

On May 10th, the great German attack had gotten under way. The main effort, of course, was being made further to the north ; but still Company C became involved in operations which, while not as spectacular as those of other Engineer companies, along the Meuse, for example, were fully as hazardous. On May 12th, the regiment to which Company C was attached moved across the Saar in an operation which had only the limited objective of establishing a bridgehead over that river. By evening of the 12th, the advanced Infantry elements (a battalion) had reached the objective—some high ground about 5 miles beyond the river. Company C was given the mission of laying minefields for the purpose of protecting the advanced Infantry against counter-attack. The terrain was such as to favour counter-attack by mechanized forces, so *T*-mines were indicated.

During the day of the advance, the company commander had gone forward with the Infantry and had reconnoitred the ground. By evening, the company was across the river, assembled in a village about a mile to the rear of the advanced elements. " *Thousands* of *T*-mines were piled in the ditch along the road. These had been brought up during the afternoon in spite of enemy artillery fire." The artillery fire was continuing.

The company commander returned to the company early in the evening, gave orders as to the route of advance, and went forward himself with the surveying detachment. Going through the Infantry positions (the Infantry was busy digging in), the company commander met the Infantry battalion commander, and together they went forward to lay out the general limits of the fields. The surveying and laying-out operations were facilitated by a faint moon. It is stated that a burning building far to the rear served as a reference point, and that the luminous dials of the compasses were life-savers. In due course, the tracing tape was laid ; and shortly thereafter, as per schedule, the " . . . squads loaded with mines appeared out of the darkness."

The mines were laid on the surface of the ground, no effort being made to bury or conceal them (but see the second paragraph below). Conditions were difficult : enemy artillery fire frequently forced the

men to the ground; the carrying distance was great; and, as the moon died and complete darkness set in, there was difficulty in orientation and control. However, a few hours before dawn, the last mine was laid.

As the last mine was laid rifle fire broke out to the front. In the darkness no one could tell what was happening; but, the company commander ordered the men to seek what cover they could find on the spot, and to prepare to repel the enemy with their own rifle fire. The fire became heavy and there were evidences that the French were launching a determined attack. At that point, the red flares went up, and the German artillery responded. The artillery barrage served to reduce the French fire, but the shells were falling so close as to give Company C cause for concern over its newly-laid minefields. Finally, at dawn, the firing subsided. Company C assembled at a point in the rear and counted the night's losses: 6 killed and 12 wounded.

During the following nights, Company C put the finishing touches on its minefields. These consisted of burying and camouflaging the mines, and fencing off the fields with "inconspicuous fences." There is a note to the effect that the French artillery had registered on the fields and had exploded some of the mines.

After five nights of work, the company had "a perfect mine plan, with an exact plot available." There followed a few days of rest, which ended when orders came for the advance to the Maginot Line itself. The mission of Company C can be guessed: it was to clear away the minefields which had been completed so recently. In fact, it appears that Company C, instead of accompanying its regiment to the Maginot Line, was given one mine-clearing mission after another. The final entry in its story, written with typical German pride, tells of the removal of 2,786 mines from a sector in front of the Westwall in a 72-hour period. That, apparently, is the record.

THE OIL SITUATION IN RUSSIA.

By " OILFIELD ENGINEER."

(Reprinted by permission, from *The Engineer* of 27th June, 1941.)

ALTHOUGH notes on the oil production in Russia were included in an article entitled " The Oil Situation in the Middle East," published in the *R.E. Journal* in September, 1941, the Nazi offensive—fully anticipated in the article mentioned—renders a full survey of the Russian oil industry very interesting.

The total production of crude oil in Russia during 1939 was 30,000,000 tons—and the inadvertent error in stating Russian production, in our issue September, 1941, as 4,433,000 tons is the subject of a correction in these columns.

Only a slight increase in output is estimated for 1940, owing to lack of modern drilling equipment with which to develop many areas which have been thoroughly checked by geophysical and geochemical methods as being potential oil-producing territory. It is this lack of good drilling equipment which has been one of the main reasons why the Nazis have not been able to obtain greater supplies of oil from Russia. Another reason, fully discussed later in this article, is that transportation facilities from Russia towards the European countries occupied by the Nazis were insufficient to carry greater volumes of oil.

The main thought in the minds of many people, however, when hearing of the German attack on Russia, has been whether the Nazis will gain further supplies of that lifeblood of modern war—oil. Careful consideration of this question results in the conclusion that although some small quantities of oil may fall into their hands, there is little or no possibility that the occupation of the main oil producing areas of the Caucasus will result in Hitler gaining sufficient quantities of oil to enable him to carry on the war for an indefinite period.

Again we would stress the fact that crude oil is useless until it is refined, and that refineries are very easily destroyed. Invasion is no new experience for Russia, and the main reason for the retreat from Moscow by " invincible " Napoleon was that the retreating Russians laid the fertile country waste. The Russian forces—fully mechanized —and appreciating to the full the fact that the Germans must, over the majority of the 1,800-mile-long fighting front, bring up oil supplies over long distances, will have made a special point of destroying

every oil storage depot, every refinery, every oil well, together with equipment, which may fall into the hands of the Nazis, no matter how swift may be the advance of the *Panzer* divisions.

The lesson of France, when the Germans were able to advance with the aid of seized petrol and oil supplies, has not been lost on

the Russians, who, it must be admitted, number among their virtues the ability to learn from others.

Some reports have stated that there were " vast stores " of petrol and of lubricating oil, together with diesel oil, scattered throughout the mechanized farms of the great Ukraine and Bessarabia cereal regions. Doubt is cast on such assertions by a report—now confirmed—first appearing in the *Schweizerische Zeitung* to the effect that an agreement to furnish 30,000 tons of petrol was signed between the Soviet Government and some Rumanian oil companies in March of this year. The petrol was required for Bessarabia and the Ukraine and as soon as the agreement was signed the Russian tankers, *Zergo* and *Moscow*, commenced loading at Constanza. It is considered that the Russians, fully aware of the fact that an attack

by Germany might be made at any moment, deliberately kept their oil storage in vulnerable areas to as low a level as possible, and the purchase of petrol from Rumania, for use in districts very easily reached by sea shipments across the Black Sea from the two great oil ports of Batoum and Tuapse, would certainly indicate that the Russians had little in the way of oil products to spare for export to Germany.

The quantity of over 30 million tons of oil per year is admittedly considerable, but the rapid growth of the use of Army mechanical transport, of the Russian Air Force, and of industries, as well as of domestic transport, calling for great supplies of oil products, makes this huge volume of indigenous oil output barely sufficient for domestic consumption, and for the building up of sufficient reserves for the great armed forces of the Soviet.

Even had transport been available for the shipment of larger quantities of oil to the Axis, it is obvious that the Russians would have had to sacrifice some of their own requirements to have shipped more than the estimated 500,000 tons per year of oil products to Germany.

Russian crude is generally of very high quality, producing a good lubricating oil and certainly better-grade petrol than can be obtained from the German synthetic oil plants or from Rumanian crude oil. It is believed that the exports from Russia to Germany covered mainly lubricating oil, of which vital commodity the Axis has been very short for many months.

TRANSPORTATION.

The question of transport to Germany is well worth detailing, as, with the destruction of refineries in Russian territory overrun by the Nazis, the only way in which Hitler can hope to use the great quantities of crude oil which may be available will be for the crude to be sent to European refineries.

The German manufacturers of refinery equipment are hard put to it to cover requirements for repairs to the Axis refineries so thoroughly battered by the R.A.F. during the past year. There is therefore, little prospect of the Nazis being able to transport refinery equipment over vast distances to occupied oil-producing areas, and thus refine the crude oil on the spot.

This point is well worth noting, as it means that the advancing German armies will have to rely on ever-increasing lengths of lines of communication, to keep their mechanized forces and *Luftwaffe* supplied with oil products.

In our article of June, 1941, regarding Rumanian oil, it was pointed out that although over 14,000 tons of oil products were produced in that country per day, less than one-half of this quantity

could be transported to Central Europe, as the peace-time exporting point on the Black Sea, Constanza, handled 85 per cent. of the total oil products.

The transport situation in regard to Russia is very similar. Exports of oil and of oil products, which rapidly dwindled during the past few years owing to increased domestic demand, and inability to boost crude production, were made mainly from Batoum and Tuapse, both Black Sea ports. The map shows Batoum to be connected with the great Baku-Azerbaidjan oilfields by pipe line. There are actually two pipe lines connecting Baku with Batoum, one carrying crude oil and the other used for petrol refined in the Baku plant. Tuapse is at the end of the pipe line system commencing on the Caspian Sea at Makhachkala, and traversing the great oil belt at Grozny.

Both these ports were, of course, invaluable for the transport of oil across the Black Sea to Odessa, where there was a refinery, and to Kherson, a few miles from the Black Sea, on the banks of the River Dnieper, where another refinery was situated.

The railways of Russia—considered by some authorities to be overloaded to three times the traffic normally carried on British or American lines—can only handle part of the oil traffic from the Caucasus, the new fields of Romny and Poltava in North-East Ukraine, the Emba district and from the Bashkiria and Izhma-Ukhta oil regions of the Ural-Volga territory. According to published estimates, railway tank car capacity on the Russian system amounted to around 500,000 tons, and the distances to be traversed, over crowded lines, must limit the annual oil tonnage carried by tank cars.

It is the inland waterway system, very highly developed, which carried the main load of oil supplies for domestic consumption, and those previously sent to Germany. Only two railway lines connected the oil areas of Russia with Eastern Germany, the route from Odessa *via* Lemberg, and the line from Rostov-on-Don, *via* Kiev and Lublin to Warsaw and East Prussia.

One waterway was up the River Bug to Brest-Litovsk, and another was up the River Dnieper, by canal to the River Pripet, and thence to Brest-Litovsk. These are the only routes by which river oil transport towards Germany could be made but they, like other Russian waterways, are frozen for almost six months of the year, and capacity is limited. Other water routes for domestic oil supplies, carried by the Russian river tanker fleet estimated to have a total capacity of nearly 600,000 tons, are up the rivers Don, Volga and Ural. The Volga route, starting from Astrakhan on the Caspian Sea, goes *via* the Gorki canal and the northern waterway network, to Leningrad, and thus served the Baltic States, annexed by the Soviet Union.

The comparatively long distances over which the river tankers

and barges must travel, and the open season of not much more than two months, restricts the annual carrying capacity of the Soviet oil fleet, especially when one considers that an average round trip takes nearly two months.

It is therefore not difficult to see that the Nazis—should they succeed in occupying important crude oil-producing areas in the Caucasus—must also capture most of the river fleet intact, if the crude is to be transported to Germany for refining. It is possible that efforts may be made to ship crude across the Black Sea to Rumanian refineries, now operating at less than one-half capacity, but the difficulties facing the Nazis in tansporting oil supplies in Rumania have already been fully detailed in these columns.

LEMBERG OIL.

There is one oil area, which may have resulted in the Nazis gaining fresh supplies, and that is the former Polish oilfield region of Lemberg. Most of the 7,000 tons per day of crude oil—of good quality—produced from former Polish fields comes from many hundreds of small wells in the Lemberg area, in which there are also many refineries. The comparatively great number of producing wells here may have been an obstacle in destroying all crude oil production near Lemberg, even though the refineries may all have been demolished by the Russians.

Crude from the Lemberg district will not have to be transported very far to refineries in Central Germany—should these plants not have been destroyed by the reputedly formidable Red bomber force. This is the only point where the Nazis can hope to gain crude oil which can be of any real service to them in the prosecution not only of the Russian campaign, but of the war in general.

The surplus Rumanian products are, of course, of considerable advantage to the Germans in their attacks on the southern part of the long fighting line, but successful advances will mean lengthening lines of communication, and increasing difficulties in the supply of oil products to forces confronting opponents far more formidable than the Poles.

The Russians have planned their strategy towards the holding of a line in the Ural region, should they be driven back behind the River Volga. War industries, and vast supplies of oil products, have been concentrated in this comparatively remote area. In line with this strategy, the oilfields of the Ural-Volga area have been fairly well developed to provide a steady supply of oil products in the event of war against Germany.

THE CAUCASUS.

The main oil-producing area is still in the Caucasus, but the details given show that occupation of this area does not necessarily mean

that the Nazis are able to use the crude oil which may fall into their hands. Increasing domestic requirements, during the past few years, have called for intensive exploitation of the Caucasian fields, many of which were great producers long before the last war, during which so many British oil companies operating in Maikop, Grozny, and the Baku district were dispossessed. Deeper sands have been found in many of these old fields, especially on the Apsheron Peninsula. The structure was traced to Artem Island, in the Caspian Sea north of Baku, where considerable drilling has been done by rigs situated on the coastline, erected on special barges, or on substantial piling structures. By means of " directional drilling " rigs located on shore can penetrate formations lying beneath the sea bed, the drilling string being deliberately and carefully turned off, at a predetermined angle, and at a specified depth, by this now widely practised method.

The same sand, developed at Artem Island, has been found at Ilyich Bay, which is close to Bibi-Eibat, a name familiar to many with former interests in the Baku area. It is reliably reported that a well at Ilyich Bay was drilled to a depth of over 7,000 ft. last year, with an initial production of more than 200 tons per day.

This success proved up a considerable area along the shores of the Caspian Sea, and drilling operations have been carried out not only along the shore line, but also on rigs mounted on piling set more than a mile from the coast.

The Baku area comes under the main area named Azerbaidjan, controlled by one of the many Soviet Oil Trusts organized to handle the many vast oilfield districts. Further recent successes in Azerbaidjan are reported at Kala, and in North Surakhany, where a very high-grade crude—well known to oil men as " Surakhany White Crude "—has been discovered in deeper sands.

Siazan, on the Caspian Sea, is a comparatively new producing area of the Azerbaidjan Oil Trust. Reports state that the area is so vast that a new oil trust is being organized to handle the district. Crude with a very high petrol content has been found at Siazan, after exploitation work dating back to 1928.

Farther north in the Caucasus, Grozny is the centre of oil activity. Very steeply inclined formations retarded deeper drilling in this area, but new and ingenious drilling methods, based on " directional drilling," have enabled successful wells to be sunk to new low levels in strata reported to be almost perpendicular. A very important new field at Oisunger, 40 miles east of Grozny, is reported, with a well producing 300 tons of high-grade crude oil per day from a depth of 5,000 ft. Being near the Makhachkala-Grozny-Tuapse pipe line, this new field has an outlet for the crude now reported to be produced from several good wells.

The main point of interest in Russian oil production is the

Ural-Volga area, which will play a very important part in the war between Germany and Russia. Ivanova, near Moscow, and Penza, west of the Volga, were new fields opened up as the result of a producing structure found at Syzran, on the River Volga. A refinery has been erected at Syzran, on this most important waterway.

Between the Bashkirian area, which includes the important fields of Tuimazy, Sterlitamak and Ishimbaevo, linked by pipe line with the refinery at Ufa, and Syzran, a new oilfield at Buguruslam has been found. Reports state that considerable production of a good grade of crude has been found at very shallow depths, and that the producing area is considered to be very extensive.

The Emba region, near the mouth of the Ural River, in the southern part of the great Ural-Volga area, includes very productive fields at Iskine, Dossor, Makat, and Koschagil. A pipe line running from Gurlev, at the north end of the Caspian Sea, into which the River Ural runs, connects the Emba region with Orsk, a refinery town, near which the fields of the Akhtiubinsk area are also linked.

Ukhta and Izhma, up near the Barents Sea, are believed to be very important oil and gas producing areas, which materially assist in meeting the demands of the new industrial area which has sprung up in the Ural region.

In the Ukraine, oilfields at Romny and Poltava were well established, and indications showed that North-Eastern Ukraine was likely to become one of the many important oil producing regions of the U.S.S.R.

Intensive surveys of the mineral wealth of the Soviet Union have resulted in oil being discovered at Nebit-Dag, in Turkmenistan; at Uzbekistan, in Mid-Asia; Tavdinsk, Siberia; Tolbinsk, Yakutia; Ayano, Sea of Okhotsk, as well as in many other areas. The domestic requirements of a Soviet Russia much more highly mechanized than at present, seem to be well covered by present and potential oilfields, and every credit must be given to the Russian Government for the manner in which hundreds of young engineers have received thorough training in all branches of the petroleum industry.

THREE IDEAS FOR TRAINING.

By LIEUT.-COLONEL C. P. WORSFOLD, M.C., *p.s.c.*†, R.E.

THE writer presents three ideas in connection with engineer training with some diffidence, firstly, because they have no doubt occurred to others and secondly, because they have been culled from various sources (other than training manuals) and are in no sense original. They have, however, been tried on the dog with beneficial results and may therefore be found useful.

Briefly they may be described as :—

(*a*) The Efficiency Test.
(*b*) The Weekly Problem.
(*c*) The Teach Yourself Lecture.

The idea for the Efficiency Test arose during the writer's sojourn in the Isles of Rest when on a memorable occasion he had an invitation to accompany the America & West Indies Squadron on their annual efficiency test.

During this test each ship in turn was put through its paces by the Commander-in-Chief, West Indies Station, who by careful planning succeeded in producing the most awkward predicaments. The ball opened quietly with the sighting of a suspicious merchantman flying an unusual flag. After a feverish search through the signal book, the Yeoman of Signals was eventually successful in identifying her as Bolivian. A boat's crew from two of the port Anti-Aircraft guns was ordered away to board her. This promptly brought down a persistent attack by a dive bomber, with the unfortunate result that the crews of the starboard A.A. guns had to keep doubling to and fro across the deck as the aircraft passed over.

The ship was then stopped to pick up the boarding party again and this was the signal for an attack by submarine.

Furiously zigzagging and very much occupied with looking for periscopes, the arrival of an enemy cruiser on the horizon passed almost unnoticed until the first salvo arrived. As a grand finale the order was given to abandon ship.

The circumstances were of course varied for each ship but not sufficiently to reduce the value of the test in showing up comparative weaknesses, not only of the handling of the ship, but also of every component part of its complex fighting and administrative organization ; and of its technical equipment.

It struck the writer at the time that this was an excellent idea

for the Field Company which also has a complex organization, much technical equipment, and many roles to perform.

In the fullness of time the opportunity arose to put the idea into practise, and this was a typical programme :—

Situation—as in the area West of Lille after the German break through and when the withdrawal to Dunkirk had been decided on, *i.e.*, enemy liable to be met in any direction, much enemy air activity, and Field Coys. widely dispersed.

Programme.

First day—

0400 Exercise began—Coy. in bivouac with perimeter defence at ½ hr.'s notice to move.

0430 Move ordered to " A " about 12 miles away at 5 v.t.m. and 15 m.i.h. through a rather complicated mass of by-roads.

0515 Coln. attacked by enemy Armd. Car *en route* to new location.

0630 Message sent ordering construction of a water point about 8 miles west of " A," limiting party to two sub-secs., material to be collected from a dump about 12 miles north of " A."

0700 Coy. ordered to construct an improvised bridge for Class 18 loads over a 17' gap about 2 miles from " A." Material to be demanded from Fd. Park and delivered by the latter. Not more than one sec. to be employed.

0800 Coy. ordered to prepare five river crossings for demolition about 25 miles N.E. of " A," not more than a section to be employed. Orders included instructions for firing. Two of the bridges were deliberate demolitions. Sec. had to find its own protection for the remaining three, which were to be for " last minute " demolition.

0830 Gas spray attack just as Coy. Comd. was giving out his orders and breakfasts were in full swing.

0900 Recce. for a F.B.E. bridge ordered—to be built after dark about 30 miles N.E. of " A."

1200 H.Q. and remainder of Coy. ordered to move immediately to point " B " about 20 miles east of " A." It was hoped that by this time only the C.S.M. would be left at H.Q. An ambush was arranged at point " B."

1500 Firing parties at three bridges attacked by A.F.V's and bussed infantry. A.F.V's engaged the protective tps. in front while small infantry parties crossed the river in boats and worked round behind them.

1700 Destruction of bridges ordered and firing parties to rejoin Coy.

1900 Two remaining sub-secs. and H.Q. Sec. ordered to construct a Tank Assault Raft at Point " B."

2300 Coy. ordered to put in a night attack and clear the dump

(about 25 miles N.W. of Point " B ") of some airborne troops who had captured it.

The enemy were known to have two light tanks with them.

Second day—

0630 Exercise ended and the Coy. spent the rest of the day dismantling, returning stores and cleaning up.

1800 Conference attended by all officers taking part on both sides.

The skeleton enemy and Umpires were found from other Coys., all of whom were only too keen to make things as difficult as possible for the Coy. under test.

The principal difficulty was to select places where work could actually be done and to ensure that the material was readily available. Since the whole essence of the exercise was to put everyone through the motions, no compromise in the way of notice boards to indicate work done in imagination could be accepted. It was astonishing what a difference this made.

It is comparatively easy on manœuvres to get away with a demolition, even if you have put all your detonators on one truck and then lost the truck.

Neither F.B.E. nor S.B.G. were used since this programme was arranged for a Corps Troops Field Coy. and therefore it was felt that improvised and pontoon bridging were of more immediate importance.

The time might well have been extended for another 24 hours to give a greater variety of work, and to include the use of other kinds of equipment.

There is no doubt that the results were most satisfactory in showing Coy. Comdrs. the weak points in their communications and administration, in the technical and tactical capabilities of their Section Officers, and in M.T. movement by day and night.

They were all firmly of the opinion that the Sections should be put through a similar test in turn, and no doubt the Section Comdrs. will do the same for their Sub-Sections.

The Weekly Problem.

This idea derives from the " F " project. It is intended to make the junior officer study his technical pamphlets in detail as opposed to reading them through cursorily.

It also affords practice in making out lists of stores required and in preparing working party tables. At the same time it gives the C.R.E. a very clear idea of the technical capacity of his Section Officers.

Problems are issued by the C.R.E. on Thursdays for return by the following Tuesday with the O.C.'s comments. This makes him too, refresh his memory from his pamphlets. With the assistance on

occasions of his Field Engineer, the C.R.E. then writes his remarks on the solutions and produces his own suggestion for solving the problem.

Three hours are allowed for most of the problems, exclusive of time spent in study of the appropriate pamphlet.

Some typical subjects for problems are :—

(1) Design of a pontoon and trestle bridge for a gap in which muddy bottom, and shallows, or high banks and deep water, make complications.

(2) Design of a water tower in tubular scaffolding. It is curious how few remember that it might be blown over before the tank is filled.

(3) A temporary water supply scheme for a Bde.

(4) Demolition of a R.C.C. bridge of design other than that in Pamphlet No. 7, *e.g.*, a 3-pin arch.

(5) Design of a M.G. emplacement with overhead cover, to include a muzzle pivot mounting and certain prescribed arcs of fire.

(6) Report on the load-carrying capacity of a trestle bridge with R.S.J. roadbearers.

(7) Design a bridge of Mk.V Pontoon Equipment and S.B.G. for a tidal gap.

(8) Design a booby trap to work by turning on a tap over a sink or wash basin.

(9) Design an improvised bridge using timber, R.S.J's, steel cubes, etc.

It is well to include a list of stores, and a working-party table, wherever they are appropriate, as part of the problem.

THE TEACH YOURSELF LECTURE.

This idea is the result of a visit by the writer some years ago to the U.S. Army Engineer School at Fort Alexandria, near Washington. This establishment has abolished the lecture as we know it, on the grounds that at least 70% of the time spent in lecturing is entirely wasted. Few can hold the attention of the whole of a class for more than 10 minutes. There may be a small number of gifted individuals who can absorb all that they hear. For the vast majority the lecturer may " cover the ground " but the student does not. It is a not uncommon practice in military lecturing to condense the matter in a training manual in order to cover the ground. Assuming that the loss due to condensation is 50% and the class only absorb 30% of the residue, the final result is that only 17% of the ground has been successfully covered. It is curious that the old established principles of education used in our early years are so neglected in adult

education. If it was necessary for us to achieve by dint of many a weary hour of study the translation of a passage from Virgil or Homer under the threat of being called upon to perform in public next day, why is it not equally desirable that we should learn our military lessons in a similar way.

The principle of the Teach Yourself Lecture is in fact preparation under the threat of public performance. The method is designed to achieve the maximum possible result in combining the channels of receptivity through eye and ear, and in retaining the interest and attention of the class.

The Instructor lays down the portions of the manual to be studied beforehand and periods are allotted for private study. At the appointed time the Instructor starts by telling a story or " painting a picture " as we prefer to call it. Having reached an appropriate situation he rouses the class to a state of instant readiness by saying " Question." The question is put to the class as a whole, much on the lines of Syd. Walker's " What would you do, chum? " After a pause of ten seconds or more, according to the mental capacity of his students, he indicates the individual to give the answer. The latter thereupon rises and holds forth—some other student is then called upon to give his opinion on the answer, and so the discussion is conducted until the Instructor has exhausted the particular point and is satisfied that he has fixed the right answer permanently in the minds of his class.

The method can readily be applied to all subjects which are covered by textbooks or training manuals. Even such subjects as military law and administration can be made to yield to such treatment. It is, however, a particularly useful technique for teaching Field Engineering. To take an example, let us assume that the pamphlet on demolitions has to be covered in two study and two lecture periods, apart from time spent in practical work.

The first thing to do is to draw up a list of the principal matters to be dealt with. This might run as follows, omitting everything that can best be taught by practical work :—

Difference between Strategic and Tactical Demolitions.
Difference between Deliberate and Hasty Demolitions.
Recce.—Equipment required and form of report.
Best methods of attack for different types of bridge.
Calculation of charges—formulæ.
Explosives—Characteristics and uses.
Organization of work.
Equipment available and its uses.
Protection of firing parties.
Firing Orders.

The story and questions can then be concocted. It is an advantage to make the story continuous for the series of lecture periods, and

illustrate it with a map drawn on the blackboard. This is no more difficult and rather less tedious than writing out notes for a lecture. The story in this instance might start at a high level with the problem of a strategic withdrawal, and the first questions might deal with the best position for strategic belts of demolition, and which roads and railways ought to be destroyed in depth.

The story can then be brought down to a divisional level and questions be asked relating to tactical demolitions, and to what demolitions will have to be left for last minute destruction, and who is to order the firing.

Bringing the story to a still lower plane, the Section Officer is sent out on a recce.; who and what does he take with him? In what form does he write his report? Where can he find the form?

Next, the story can deal with what officers find on arriving at various bridges—and questions can be asked as to the method of destruction, the calculation of the charge, the time it will take to prepare, the type of explosive required, and the equipment to be used.

Then the Section can be sent out to prepare its bridges, etc., and questions can be asked on organization of the work and how the trucks should be loaded.

Finally, the story can be brought down to the point where firing orders have to be given in one or two different situations and questions can be asked as to the composition of the firing parties, how they should be protected, what arrangements must be made for their withdrawal, and under what circumstances they should fire if they have not received the order from the named authority.

Although by this method it is not of course possible to mention as much during the lecture periods as in the normal lecture, the omissions are amply compensated by the fact that the class have had to devote real care to the preliminary study of the manual, and in fact have probably already made notes on many important matters in order to be prepared for possible questions. It is not advisable for the student to have the manual open in front of him during the lecture period, although it is desirable that he should have it beside him to be opened only when the Instructor wishes to direct attention to some particular matter.

A POLISH SAPPER AND MINER COMPANY IN ACTION.

By LIEUTENANT K. BILSKI, POLISH ENGINEER CORPS.

(Note—Lieut. Bilski's Company was attached to the 10th Polish Motorized Cavalry Brigade in the fighting described on pages 371-9 of the September, 1941, R.E. Journal.)

THE Sapper and Miner Companies formed of Engineer troops in the Polish army, several years before the present war, were mainly intended to oppose A.T.V's by means of A.T. mines and demolitions. Their mission was mainly defensive, a mission amply justified by Poland's conception of any possible war. They formed part of Engineer Battalions of Armies or Mechanized Cavalry Brigades, or of some Infantry Divisions.

The plan on page 477 shows the establishment of the Company, from which it will be seen that it was equipped to carry out the following tasks :—

(1) The demolition of roads, bridges, etc.
(2) Laying mine fields.
(3) A.T. obstacles and traps.
(4) Destruction of fords.

The *Reconnaissance Patrols* had, besides their normal duties of engineer reconnaissance, other tasks :—

(1) Passing information between tactical units and the demolition parties working in their areas.
(2) In many cases the decision when to fire the charges.
(3) Covering the demolition parties when working independently of tactical units.

A *Mining Patrol* was organized to work at five different places at once. An *Abatis Patrol*, with its mechanical equipment, was capable of constructing an abatis in a wood, armed with mines and traps, about 50 metres long, in about 2 hours. The *Special Patrol*, with its motor pump, was mainly intended for the destruction of fords. This was done by driving special pipes into the bed of the stream, pumping water down them until suitable chambers were formed for the 7-lb. charges, whereby craters of 4 yds. diameter were obtained. The *Technical Platoon*, besides the H.E. and fuses, carried sufficient petrol to supply the Company for a 320-mile march. Owing to the light type of its vehicles the Company was very mobile.

The Company whose action I am about to describe had been under my command for two years and remained so during the whole

campaign. Two weeks previously it was attached to the 10th Motorized Cavalry Brigade. This Brigade, as a covering unit, was awaiting the outbreak of hostilities in the environs of Cracow. The opening of the campaign, with the German attack in the early morning of the 1st September, has already been described by Lieut.-Colonel Skibinski.

I will begin my story with the 3rd September, when the Company first went into action. The Company was then billeted in the forester's house at Pcim. On the preceding night 3 mining and 2 reconnaissance patrols had prepared for demolition and laid out mine fields at 1, A, and B, (see *Map* 1) and at each object firing posts, each two men strong, were detailed.

That morning my Company received orders to prepare demolitions and lay out A.T. obstacles in the Jordanow-Tokarnia and Krzeczow-Lubien areas, held respectively by our 24th Lancers and 10th Horse Rifle Regiments. Special attention was also directed to the Pcim region, where the conditions for very important demolitions prevailed.

The order also stated that the Engineer working parties were to be covered by the fighting troops, that the demolitions in the Letownia and Lubien areas must be ready for firing before 2 p.m., and that the commanders of the fighting troops had been given general information about the demolitions.

It will be seen from this that the time allotted was very short and that, as the enemy were fully motorized, the number and quality of the demolitions might materially influence his speed of movement. The reason for the especial importance of the Pcim region was that it was the point of junction of many roads from the south. Demolitions at that point would obstruct the only road leading north to Myslenice and Cracow.

Owing to the limited time at our disposal normal reconnaissance were impossible, and I decided to distribute my working parties from an appreciation of the terrain as shown in the map.

I consequently sent to each area an officer with one reconnaissance patrol and two mining patrols. In order to ensure a rapid supply of H.E., I sent two truck-loads to the bridge marked 7c in *Map* 2. As I expected that there might be a further retreat on the following day, I sent a patrol to reconnoitre the Pcim-Myslenice line.

About noon I received information that the demolitions numbered 2 and 4 on *Map* 1 would be ready before 1 p.m., and that my demolition project for the eastern area had been accepted by the commander of that area.

In view of the importance of the Krzeczow-Pcim road, I accompanied that patrol myself in order to judge the probable effectiveness of the proposed obstructions. I found that the bridge near Teczyn (No. 3 on *Map* 1) was not very important, as its demolition would

Scheme of the organization of a motorized sapper-miner company

o.c. & coy H.Q				Reconnaissance platoon			Miners' platoon					
o. c.	disp. rider	wireless	med. patrol	o.c.Q.patrol	patrol 2.	patrol 3.	o. c.	min.patrol 1.	patr. 2.	patr. 3	patrol 4 barricading	patrol 5 special
4 seat	motorcycl.	truck 10 cwt	truck 10 cwt	4 seat, motorcycle, truck 10 cwt	as patrol Nr. 1			lorry 20 cwt, 1 earth drill. 20 cwt	as patrol Nr. 1.		Cars as with patrol Nr. 1. Equipment: Electr. gener. 2 electr. drills/ 2 " saws/ 200 pds. H.E	Equipment: Motor pump 200 pds. H.E
20 AT min.				20 AT mines/ 1 M.G.				700 pounds H.E 50 AT mines				

Technical platoon

Amunition cars	Mining equipment & spare parts for motor cars	Administr. section	Break-down patrol
lorry 40 cwt, trailer with oil tanks; lorry 40 cwt, 50 gall.; lorry 40 cwt	lorry 40 cwt, trailer with oil tanks	lorry 40 cwt	truck 10 cwt; truck 10 cwt
1100 pds. H.E. + 650 fuses + 650 A.T. mines/empty/ + 150 various fuses + 400 pds. barbed wire	1 mechanic saw, 1 rubber boat, spare parts	Kitchen utensils	

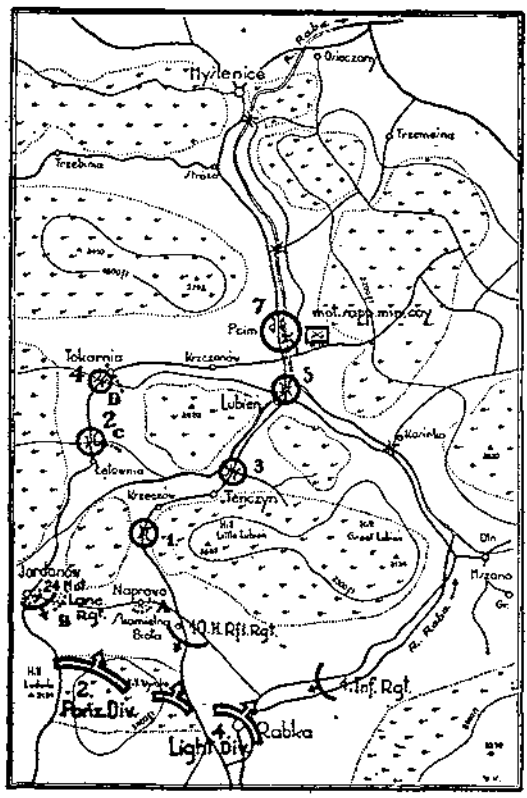
General synopsis

Pers. establish: 6 off. + 56 N.C.O. + 86 privates
Light M.G. - 3
Motorcycles - 5
Motorcars 26
H.E 5000 pounds
A.T. mines - 550
A.T. mines /empty/ 2 000
Electr. & mechanical saws 2
Earth drills /Ø 12"/ - 4
Electr. generator 1, Motorpump 1

W.K

cause only about two hours' delay to enemy motor-cars and cycles. The bridge near Lubien appeared to offer more favourable prospects. With the bridge demolished and a mine-field laid on both sides of the road it might be hoped that the enemy advance would be checked for a considerable time. His motorized infantry and tanks would then be obliged to make a détour over the mountain slopes which

Map No. 1.



would be very advantageous to us. The bridge could not be reconstructed under 4 to 6 hours. But the bridges at Pcim (see *Map* 2) were far more important. Demolitions and obstacles carried out there would effectually hold up the enemy's advance, and the terrain offered good conditions for the defence of the obstacles. I anticipated that the enemy might be halted there for as long as the defence could resist them, and even then the reconstruction of the bridges would require some considerable time.

The mining patrols began with the work on Nos. 3 and 5 (see *Map* 1) and finished by 4 p.m. The work was delayed by the want of proper drills. The stone embankment made the use of our drills

ineffective. Pneumatic drills would have shortened the time by one-half. It was only possible to bore drill-holes and successively fire in them 4-lb. charges of trotyl. In this way after three hours' work 6 shafts of sufficient depth were ready, and the normal charges of H.E. had to be doubled. The main charges on bridge No. 5 were 240 lb. each.

During the morning I presented the O.C. 10th Horse Rifle Regiment my scheme of demolitions in the Lubien area. He did not agree to the mine-field at the bridge, as he was afraid of not being able to inform his fighting units of its existence. All the other arrangements were approved. He ordered me to place warning posts at the mine-fields Ei and Eii (see *Map* 2) and to leave them until dark. He added that during the afternoon he was going to organize a second line of defence on the heights 2702 and 2450 north of Pcim in order to cover by fire all the projected demolitions. The order to fire the charges was to be given by the O.C. Brigade Reconnaissance Tank Platoon, which was to be the last to retire. It would however be advantageous if one of the Engineer officers could establish contact with him and explain the arrangements. I despatched the commander of my company reconnaissance platoon on this mission. On my way back to the Company I informed the sappers at the various posts of the general situation and the arrangements for firing the charges.

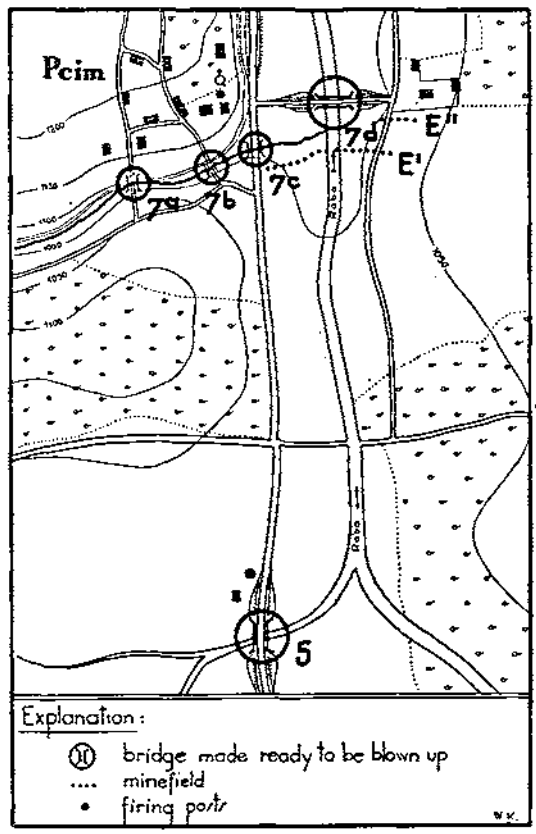
I decided to remain for the rest of the day at the Pcim bridges, where the last mining patrol was working. It was an excellent post for the company commander as the traffic passed that point from all directions, including the despatch riders and the returning mining patrols of my company. By questioning despatch riders and passing officers I was in a position to gain the latest news from the battle-field and by this means to control the work of the engineers.

About 2 p.m. the enemy delivered a strong attack on the Lubien heights, slowly driving back our troops towards the north. A sapper who passed reported that the bridge at Krzeczow, of which he had been in charge, had been blown up. A few hours later I learnt from another sapper that the bridge at Tenczyn had also been demolished. They had experienced great uncertainty as to when to fire the charges, as they had not seen our tank commander nor received orders from anyone else, but when the enemy were only a few tens of paces distant they had fired the charges on their own initiative.

About 6 p.m. the enemy were approaching Letownia and Lubien and our troops, retiring in motor-car columns along the high road, became more and more numerous. The mining patrols from both areas began passing, reporting that their work was ready. The officer whom I had sent with the eastern party reported that he had had a lot of trouble with our retreating troops, one section very nearly walked over our mine-field near Letownia, and near Tokarnia a

peasant cart struck our mine-field, marked D in *Map* 1, owing to the negligence of our warning picket. The mine-field had been re-established and the inhabitants told how to avoid it. My Battalion Commander passed and asked me what objects had already been blown up, and he told me that in the morning German infantry had passed over our mine-field in the Naprawa region. He had witnessed

Map No. 2.



it from his observation post. The Germans as soon as they became aware of the presence of mines retreated helplessly.

In the meantime the works in the Pcim area were nearing completion. That on the road bridge (7c in *Map* 2) offered the greatest difficulties. The ground there was practically all rock. Again the shafts had to be drilled like mining and the charges increased four-fold. While talking to the Battalion commander I had missed seeing that the western wing of the mine-field was being made too close to this bridge, so that the blast of the demolition might have destroyed several of the mines; I consequently moved the wing some 20 to 30 yards forward.

Meanwhile the sounds of battle were coming nearer and nearer and troops in small columns were retiring on both sides of the road to occupy a new line of resistance. I was awaiting impatiently the return of the officer whom I had sent to the commander of the tank platoon, for if he had failed to find him, the firing post at the Lubien bridge would remain without orders and this important communication might be left intact. Actually this officer never returned.

The fight was intensifying. The enemy twice attacked with light bombing aircraft. About ten planes took part in each attack and, firing from a height of from about a hundred to two hundred feet, machine-gunned our troops and bombed the roads. Several bombs fell near the bridge and one hit a motor-cycle carrying two N.C.O's. The German artillery now directed a heavy fire against Lubien. It had evidently moved forward and was now supporting their infantry attack. Should they occupy Lubien the whole Jordanow road would come under their fire and it would be difficult to withdraw our firing post. To my relief I then heard a loud explosion in that direction and appreciated that they should still be able to join us.

The German artillery were soon directing their fire on the north side of Lubien and still the reconnaissance tank platoon had not arrived. I asked several officers from the front for news of it but they could tell me nothing. At last I decided to go forward myself. Our units, apparently the last ones, were running out of the woods near Lubien, jumping into cars hidden in the village and driving off. The enemy directed his fire on the parking place, but all got away in time and none was hit. I was lying with our firing post in a ditch by the roadside. It was the first time that I had experienced a battle and as the cars passed I saw that the men were very exhausted, covered with dust, and some were wounded.

Again the enemy advanced his fire and shells fell in front of the bridge (7c in *Map* 2) that we were waiting to demolish. One fell so near that we were compelled to change our post. We hid behind a barn, but the thatch caught fire and the barn was soon ablaze. Again we had to move, this time to a shell crater, the men carrying the leads and I the exploder. The men looked enquiringly. Should not the bridge be blown up ? But our tanks had not yet come.

The Germans were now to be seen among the houses of Lubien, within 500 yards of us. Now, in turn, our artillery was directing its fire on Lubien. The Germans moved off eastwards into the woods, but after a little time they renewed their advance towards us. Soon they would be upon us.

I was beginning to get anxious. Should I demolish the bridge or wait a little longer ? If any of our tanks or cars remained at the front their retreat would be cut off. At that moment two tanks appeared from the west of Lubien, but were they ours ? They were advancing on us, followed by two more just debouching from the woods. I

ordered the key to be put into the exploder. We strained our eyes. They were ours.

The Germans opened fire on them but it was ineffective. Soon they had reached the road. I signalled to them to stop and enquired for their commander. He was in the fourth tank. I asked him if I could now blow up the bridge. Apparently one tank was still behind, so that I could still get no reliable information. The Germans started firing on us, they hit the last tank without damaging it and then wounded my corporal in the leg, seriously, as I found afterwards.

I still did not know whether to blow up the bridge or wait for the remaining tank. But the Germans were coming nearer. A few tanks appeared from the western outskirts of Lubien, and I saw shells, evidently our own, bursting near them. That cleared up the situation, our missing tank would not return. At last I decided to fire the charge. The bridge was blown sky-high—a terrific explosion—1200 lb. of H.E. The hills reverberated with the echo. The sapper exclaimed with relief "All in order." Then we withdrew, and I realized how difficult was the task of a firing post under the circumstances.

The Germans occupied Lubien and the adjoining heights but did not continue their advance that day. Returning to Peim I found everything in readiness. The cables to all the charges had been brought together into a common station and it was thus possible to fire them successively or simultaneously. The firing posts were on the alert. Dusk was falling. The sounds of battle grew weaker and with the first cold night breeze silence fell on the battle front.

I have described portions of a single day of our fighting. There were many more like that. The German armoured divisions continued to press our troops with all their force. During the whole campaign we continued to retard the enemy's advance over 400 kilometres. There was not a single day of rest. By the 18th September, our losses had amounted to 50% of the effectives and as much of our equipment. Often the men detailed to fire the charges stuck to their posts under heavy fire for many hours. Many were wounded, but in spite of wounds executed their tasks. Very often a unit, expected to return the last and to give the order to fire the charge, never returned, but was destroyed in the fighting, and only the coolness and reasoned initiative of a single sapper decided the success of our efforts.

Out of 110 objects of varying importance only three fell into the enemy's hands undamaged. At two of them the firing posts were killed, and at the third their nerves gave way under continual bombing. When remembering the soldiers of that company I cannot help being moved. Their great enthusiasm and unbroken fighting spirit reacted on other units. They kept their high morale up to the

last day of the war. After the defeat of our army they passed into France, where they valiantly sustained another catastrophe. In this country there are still 26 of them. When discussing our adventures we sometimes say laughingly " In the whole world there cannot be such another Sapper unit. It has helped to retard the enemy's advance from Poland to Scotland, about 2,000 kilometres."

The following conclusions may be drawn from our experiences in the campaign in Poland :—

(1) Sapper and miner companies organized and equipped as shown in this article are of value only in the defence. When supported by relatively small numbers of A.T. arms and infantry, they can check an enemy's advance for a time in any kind of ground.

(2) Their equipment must be judiciously selected and adapted to their most difficult conditions of work. The specialization of some patrols, and even platoons, to a given kind of work, is not advisable. All should have uniform organization and equipment so as to be able to carry out every kind of task, whether demolitions or obstacles.

(3) The decision when to fire a charge is a very difficult matter. Soldiers charged with that duty should be instructed with the situation, and they must finally make the decision from information received from the troops in final contact with the enemy. They must be courageous, with plenty of intelligence and initiative.

(4) At all larger demolitions at least two men should be left as firing posts. The so-called " enemy hunting " may often produce disastrous results, as the enemy, if allowed to come too near, may kill the firing post and gain the object undamaged. Directly the demolition becomes possible it should be carried out without delay.

(5) A.T. mines should contain at least 4 kgs. of H.E., for otherwise they are too weak to destroy tanks.

(6) Staffs of the larger units should carefully study the employment of A.T. mines within their units, in fact all O.C. units of every description should understand the use of these mines. Principles for their use should be established in the whole army and rigorously observed.

(7) In a retarding action the ground conditions often make it impossible to bring fire to bear on completed demolitions. In such cases the defence should be reinforced by traps and mines.

RECENT WELDING DEVELOPMENTS.

By C. W. BRETT, ESQ., M.INST.W.

IN due course, when conditions allow of a truer perspective, it is likely that we shall realize how much we owe to the seemingly small things which so often have a potent cumulative effect.

As in other spheres of activity the foregoing is true of engineering, and scientific welding provides a pertinent illustration of this fact.

The importance of repair work carried out by welding methods is generally realized to some extent, but few, unless they have studied the subject with care, appreciate to what degree it is aiding the national effort apart from its value as a rapid and dependable means for many classes of fabrication. For example, in numerous ways we have acquired foreign equipment; ships in particular. The question of maintenance is one of paramount importance, for delay in operating existing craft is just as serious as a hold-up in new ship production. Much of the machinery, particularly Diesel engines, are in need of renewals but the source of supply is cut off. What can be done? First and foremost, welding is being used in a large proportion of cases to re-condition parts that have fractured. The same methods can be applied to components that are whole but worn and call for attention.

The advantages are speed, low cost and dependability. Many of the items after treatment are actually superior to new replacements, for subsequent to fracture some can be made stronger than before, whilst the new metal applied to a worn area is often better able to stand up to the conditions of duty than the original material.

It is the same in other directions, machine tools are being handled on similar lines in increasing numbers, together with transport vehicles and other equipment of direct military interest.

Before dealing with more particular applications it is desirable to point out that intensive research has much increased the scope of this class of repair work even during the past year or so.

One of the latest developments, which is the outcome of painstaking investigation covering a period of years, is a process whereby metals of a totally dissimilar nature may be welded together. Until recently many qualified engineers considered this to be beyond the bounds of practical achievement, at least on a commercial basis, because of the wide variations in the co-efficient of expansion. Nevertheless the desired objective has been reached and results are without need for qualification or concession in efficiency. Even such

an extreme example as the welding together of steel and aluminium is quite feasible. Observed tests to destruction invariably cause the weaker parent metal to yield first and failure does not occur along the line of union, thus proving conclusively that a true weld results.

FIG. 1.—Crankshaft of Diesel engine, broken through a web. Fractures also sometimes occur through the journals. These breakages often happen without giving any warning.

The stresses to which a component is subjected in the normal course of service do not prevent welding being employed successfully. An outstanding illustration of this is the very large number of crankshafts that are re-united after fracture. It should be made clear that such exacting work is in no way a war-time expedient brought about by the difficulty of securing replacement parts promptly. When such renewals were easy to secure, this remedy was the accepted

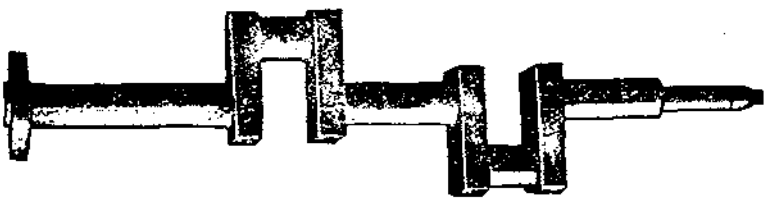


FIG. 2.—Welding specialists are constantly repairing broken crankshafts, and building up the journals of worn ones. It is not sufficient merely to weld the fracture, but the crankshaft must be perfectly straight and all journals in alignment. Remachining the journals back to original size and lining up the shaft are part of the repair operation.

practice of many large firms. Although the majority of the cranks handled have belonged mainly to the power units of road vehicles, similar components of far larger size have been re-united after breakage and under the usual guarantee given by scientific welding engineers of repute. Recently the crankshafts of two large stationary Diesel engines were repaired. One measured 16 ft. in length and the other 14 ft. A large marine engine crank, together with that of a railway locomotive having inside cylinders, were also repaired. In this connection it must be remembered that sudden fracture is often

complicated by severe distortion and obviously the question of re-alignment is all important.

Welding skill of a high order is essential therefore with all repair work but it is seen at its best when dealing with cranks, for accuracy in all respects must be assured to within a tolerance of r,oooth part of an inch. Men capable of this responsible work cannot be trained quickly, owing to the exceptional versatility and experience needed to undertake many varieties of repair with absolute certainty of success. It is for this reason that much is demanded of specialist firms, who, subsequent to welding, can undertake any class of machining that may be needed.

Not only do the methods outlined provide an important means for conserving supplies of new material but they enable lost efficiency to be regained. It is surprising how many motor vehicles are in operation with deeply undercut valve seats, which is the outcome of repeated regrinding. To recess the cylinder block to receive inserts is seldom satisfactory. The casting may be made dangerously thin and an insert sometimes has the unfortunate characteristic of being satisfactorily gas-tight in a cold engine and blowing when running temperatures are attained.

By far the most trustworthy solution is to build up the old valve seats with special metal, which is better able to resist heat and valve hammer than is cast iron. Carefully observed tests of engines so treated have shown reduced fuel consumption up to so much as 20 per cent.

Cracked heads and cylinder blocks belonging to motor vehicles are welded in very large numbers without leaving a trace of the work that has been done. During the winter months it is not uncommon to receive frost-fractured castings broken into a large number of fragments and examples which seem beyond all possible hope of restoration are repaired perfectly.

A point of importance is that during periods of severe frost most metal parts are more prone to fracture. Gear wheels will not stand up to the same shock load as when they are warm. So marked is this characteristic that it was found necessary to keep rear axles and gear boxes warm, as well as the engines of ambulances and other vehicles required for service at a moment's notice, and used by the American Red Cross contingent operating in Finland and Norway earlier in the war.

Even when teeth have been broken away and maybe lost, they can be built up afresh by welding skill and then re-cut and ground with the utmost accuracy.

Within the space of a brief article only the fringe of possibilities can be mentioned, but the object will be served if only those who are faced with some mechanical emergency will remember the resources which scientific welding provides.

R.E. CHINESE JUBILEE CELEBRATIONS.

The Fiftieth Anniversary of Chinese Sappers.

By CAPT. H. C. G. CARTWRIGHT-TAYLOR, B.A., R.E.

FIFTY years ago the first Chinese Sapper was attested in the Corps of Royal Engineers. It was a step that had taken five years of discussion and difficulties to reach, but that it was a wise step no one who has known and worked with the Chinese Sappers can have any reason to doubt.

Like many of our good institutions, the origin of the Chinese Section of the Royal Engineers lies in the Submarine Mining duties of the Corps. In 1878 a Submarine Mining detachment was sent to Hong Kong, a detachment so small that it was capable of little except the care of its stores, and, to make of it an active unit, it was reinforced by the engagement of Chinese civilians, mostly boatmen.

On the 1st August, 1891, No. 1, Cheong Sow, was attested Sapper and was at once promoted Havildar-Major. This " recruit's dream " of promotion was not so strange as may seem at first sight, as Cheong Sow, together with forty-nine other Sappers who were attested shortly after him, had been employed by the Hong Kong Company for some years as civilians and were all trained submarine miners ; thus although they changed their status they did not change their employment. Cheong Sow served for five years and died about seven years ago.

Until 1905 the Hong Kong Company, about one hundred strong, half British and half Chinese, was employed in submarine mining duties with detachments for Defence Electric Lights and Brennan's Torpedo, the Chinese mostly doing duty as boatmen, though some had the trade of telegraphist. It was an efficient company and left a record, established in 1904, which was undefeated by any other Company when the Corps handed over its submarine mining duties in 1905. After two hours of preparation, one hundred and ten mines were laid in six hours and only two mines required attention before a perfect test was reached.

In 1905 the Corps handed over its submarine mining duties to the Royal Navy. The Submarine Mining Battalion was disbanded and in all ports, except Hong Kong, the locally enlisted troops were paid off. The Hong Kong Company was reformed as the 40th (Fortress) Company, and retained its Chinese personnel ; thus although they

were not the earliest locally enlisted troops in the Corps, they are the only portion who have retained their unbroken service to the present day.

The period from 1905 to 1914 was uneventful in Hong Kong; the Company duties were on Engineer Services and the maintenance of Defence Electric Lights which had been installed about 1896 (the date of the Hornsby Ackroyd Engines, the last of which was in existence in 1940). Among the Chinese the trade of boatmen disappeared and those of electrician and engine driver predominated.

During the war of 1914-1918, the Chinese Sappers remained in Hong Kong and were employed largely on the maintenance of the Defence Electric Lights, which were manned at night by the Hong Kong Volunteer Defence Corps, and, although they were styled as part of the Eastern Expeditionary Force, they did not receive any war medals, as it was ruled that they had not left their home station.

The period after the war was one of retrenchment and saw the cutting down of Coast Defence Establishments, but in spite of this the Chinese Section increased its numbers and rose from a total strength of about fifty to over seventy. The reason for this was two-fold; first, there was a tendency to replace British Sappers with Chinese wherever possible; and secondly, a large number of duties in the Engineer Services, which had previously been performed by civilians, were taken on by Sappers; for instance, a Chinese Sapper ran a fan repair shop for the Engineer Services, and various small water pumps in barrack areas were also under their care. About 1935, this practice was stopped, and the Sappers were withdrawn to more active defence duties, which were by now on the upgrade again.

In 1936 the modernization of Hong Kong's defences was well under way and additional men were required. Coast Defence had increased and another Fortress Company had been formed for Anti-Aircraft duties in 1934. Each year saw an increase in the number of Chinese Sappers and since 1937, when the 22nd (Fortress) Company received its first draft of Chinese, more Chinese have been enlisted than in the previous 45 years.

Recruiting has never been difficult. An announcement in the local Press is sufficient to cause a major traffic problem outside barracks and at least ten candidates for every vacancy, and there are continuous applications to be placed on the waiting list. Recruiting arrangements were originally all Regimental, but recently a Command Board has been formed to recruit for both the Corps and the Royal Artillery, which has now followed our lead in enlisting Chinese.

Originally the terms of service were:—initial enlistment for one year, and re-engagement for five-year periods up to twenty-one years and a year at a time thereafter. This has now been altered,

the initial one-year enlistment being removed. A large proportion have served twenty-one years and the longest service recorded is twenty-five years.

The language difficulty is not great, as most of the men have a knowledge of English (a permanent civilian instructor is employed) and the N.C.O's are in many cases good interpreters.

The bulk of the Chinese Sapper's training has always been directed to fitting him for his Fortress duties, but in latter years a good deal of it has been directed to field works, for which he has a marked aptitude. A background of thousands of years of agricultural engineering with a minimum of equipment has produced a courage and resource with " stick and string " which would be the envy of many Field Companies and would cause heart-failure to any Factory Inspector.

In the days of submarine mining, when the trade of boatmen was all-important, the bulk of the intake was from the country folk (Hakka) in the neighbourhood of Hong Kong, who have lived for generations by farming and fishing, but with the change to more advanced engineering the more highly educated Chinese town dweller now forms the bulk of the Section, and his qualities of slighter physique and quicker brain are more fitted to Fortress duties than was the more solid farmer.

Originally the ranks of the N.C.O's were named after the Indian style—Havildar-Major being the top rating. Tradition has it that this is a relic of the Indian instructors who were originally employed to teach the civilian submarine miners their military duties, but it would seem more probable that at a time when the influence of India on the Army was very high it would be natural for the authorities to bestow their ranks on all non-Europeans. For fifty years these Indian ranks have been a cause of complaint among the Chinese, but now they are known by them no longer and are Corporals and Serjeants.

The technical standard obtained from the Chinese is high and his infinite capacity for taking pains produces a tradesmen of high order, though his methods may be unorthodox to British minds. Although always armed, it is only recently that their training has included a full course of musketry and many of them have proved very adequate shots.

On the 1st August, 1891, Cheong Sow was attested. On the 1st August, 1941, the Chinese Section celebrated this and showed to the people of Hong Kong that they had achieved something in fifty years of which the Colony could be justly proud. At a Ceremonial Parade, at which His Excellency Sir Geoffrey Northcote, Governor of Hong Kong, took the Salute, they called forth from His Excellency and the spectators alike the highest praise for their steadiness and bearing.

The afternoon was given over to Swimming Sports, about the only competitive activity the climate would permit, and in the evening they and their officers gave a dinner at which they were honoured by the Governor, the General and the leading Chinese personalities of the Colony, all of whom spoke, in conversation or address, in nothing but the highest terms of what they had seen and learned of the activities of the Sappers.

After fifty years the Chinese Sappers have built up a tradition of which they and all who serve with them are rightly proud, and they have shown their worth in the many emergencies which confront a Sapper from time to time, as well as in the unsung routine of the Barrack and Fortress. Let us hope that in another fifty years they will celebrate an even more glorious Centenary.

MEMOIRS.

MAJOR-GENERAL SIR SYDNEY D'A. CROOKSHANK, K.C.M.G., C.B., C.I.E., D.S.O., M.V.O.,

COLONEL COMMANDANT ROYAL ENGINEERS (Retd.),

Knight of Grace of the Order of St. John of Jerusalem.

SYDNEY D'AGUILAR CROOKSHANK was born in India on 3rd June, 1870. His family on the male side are descended from the Rev. John Crookshanks, of Raphoe, who migrated from Scotland to the North of Ireland early in the seventeenth century, members of the family being actively employed during the siege of Londonderry in 1688-9.

Sydney belonged to the fourth generation of a direct line of soldiers. Thus, in 1799 his great-grandfather, Colonel Chichester William Crookshank, K.H., joined the 68th Regiment of Foot as an Ensign and served with distinction in the Peninsular War, being wounded and having two horses shot under him at Salamanca. He also served in the Walcheren expediton. He was presented with the freedom of the cities of Dublin, Londonderry and Limerick.

His eldest son, Captain Blackman Chichester Graham Crookshank (Sydney's grandfather), served with the 51st Regiment of Foot.

In turn, the eldest son of Blackman, Colonel Arthur Chichester William Crookshank, C.B. (Sydney's father), joined the 35th (Royal Sussex) Regiment, as an Ensign at the age of 18 in 1859. He subsequently joined the 32nd Pioneers, whom he commanded in the Afghan War of 1878-80, being promoted to Brevet Lieut.-Colonel at the close of the campaign. After a period of several years of distinguished service as Assistant and Deputy Secretary in the Military Department of the Government of India, for which he received the thanks of the Viceroy and the C.-in-C. and the distinction of the C.B., he was selected to raise the 34th Pioneer Regiment. Finally in 1888 he was appointed to the command of the 4th or River Column of a punitive expedition against the tribes of the Black Mountain in the Hazara District of the N.W. Frontier of India, in which capacity he was mortally wounded during a reconnaissance near Kotkai and died at Haripur on 29th October, 1888, from the effects of the wound.

A four-generation series which surely forms a noteworthy record of military continuity in the family tree over a period of a century and a half. But this military tendency of the trunk of the tree in a vertical direction is, one may say, even surpassed in the case of Sydney's generation by the lateral spread of its branches. For of Colonel Arthur Crookshank's five sons, of whom Sydney was the

second, every one joined the army, and the one daughter also married a soldier.

The five sons were :—Colonel Chichester de Windt, R.E., *D.L.*, *J.P.*, *M.P.* (of His Majesty's Body Guard and the Royal Company of Archers), Major-General Sir Sydney D'Aguilar, R.E. (the subject of this Memoir), Lieut.-Colonel Arthur Alexander, R.E., Captain Wilfred Plassy, 1st K.G.O. Gurkha Rifles (killed in action at Kut in 1916), and Major Claude Kennedy, 34th Sikh Pioneers.

The daughter (Ethel) married Captain Cecil Hunt, M.C., 34th Sikh Pioneers, who was killed in action at Givenchy in 1914.

As regards present and future continuity in the military traditions of the family :—the fifth generation is represented in the army by the following regular officers now serving, Chichester de Windt's son, George Howard Usher, of the 3rd K.O. Hussars (Royal Armoured Corps), Claude's son, Arthur Kennedy, a Major in the Scinde Horse, and Mrs. Hunt's son, John Cecil, of the 60th Rifles.

Furthermore, a son was, a few weeks ago, born to the wife of the above-mentioned Arthur Kennedy Crookshank of the Scinde Horse and is already destined for the Indian Army, thus giving hope of a sixth generation in direct line. Another interesting point in the family's military record is that out of the five generations at least one member of each generation has been wounded on service.

Sydney's mother was the eldest daughter of the Rev. J. B. D'Aguilar, the grandson of Baron D'Aguilar, an eccentric character in the late 18th century and a descendant of a Spanish family of distinction in the Middle Ages.

Sydney Crookshank was educated on the Continent and at the Royal Military Academy, Woolwich. He passed out sixteenth in Colvin's batch of twenty on 27th July, 1889. After the customary two years at the S.M.E., Chatham, he elected for continuous service in India, where for his first two years he was employed on railway survey and construction (Mari-Attock, Rae Bareli and Sind-Saugur). He then transferred, in 1893, to the Roads and Buildings Branch of the Public Works Department in the United Provinces, which employment may be said to have claimed his services practically continuously for the next eighteen years.

Not the least noteworthy of his varied experiences occurred early during this period, in connection with the well-known incident of the Gohna Lake. Although this was a topic of widespread interest throughout Northern India at the time, so many years have since elapsed that it may be fitting to give a brief account of it here.

Gohna is a small hamlet remote in the heart of the Himalayas and is situated on one of the tributaries of the river Ganges, some 150 miles upstream of the city of Hurdwar, at which latter point the Ganges debouches from the Himalayan foothills into the main Gangetic plain.

Maj-Gen Sir Sydney D'ACrookshank KCMG CB CIE DSO MVO

Hurdwar is important both as being one of the most sacred of all the Hindu holy cities and as being the site of the headworks of the great Ganges Canal, which irrigates over a million acres. From Hurdwar upwards the Ganges forms the only highway for the numbers of Hindu pilgrims who journey up to worship at the sacred shrines of Badrinath and Kedarnath, halting at numerous populous villages by the way. Some time before the end of 1893 native reports began to trickle in that an enormous landslide had occurred near Gohna and that the river was being dammed up thereby and was thus heading back to form a large lake. Crookshank was detailed to report on the situation, to watch the growth of the lake and to advise upon the steps necessary for the safeguarding of life and property.

The selection for this duty of so young an officer, with a bare two years' practical experience, is a testimony to the high opinion already formed by Crookshank's superiors of the capabilities of which he was to give such ample proof in after years.

On arrival at the site he reported that a whole mountain side had collapsed from a height of 4,000 feet and for a length of more than a mile and had entirely choked up the valley. The dam thus formed was about 1,000 feet high, of enormous thickness, and composed of earth, shale and gigantic masses of rock, some of the latter being, as he shortly afterwards told the writer of this Memoir "as big as the Secretariat at Allahabad." The pent-up water was already headed back a distance of 1 mile.

All possible protective measures were set in hand. It was impossible to lower the dam to any useful extent or to regulate the outflow of the torrent which the bursting of the dam would liberate, but a temporary telegraph line was constructed for the despatch of constant reports and warnings, some of the various suspension bridges over the Ganges were dismantled and the height of the canal headworks regulator at Hurdwar was increased by temporary crib work. Also ample warning was given to all residents in the valley and to pilgrims.

By July, 1894, the lake had grown to 2 square miles in area and was 620 feet deep. Public interest in the matter developed into excitement as time drew on. Crookshank's methodical observations of rainfall and his record of the contours, cross section and bed slope of the valley enabled him to make a fairly accurate forecast of the date on which the level of the lake would top the dam, but opinions varied as to what would then happen.

One theory was that, as the dam was of so great a thickness and contained such enormous masses of rock, the escaping water would not be able to cut down into it to any very great depth and that a permanent lake would be formed of an area not much smaller than

the maximum attained at the time of the crisis. The contrary theory, held by many, was that the whole dam would go.

Matters reached a climax late in August, 1894, by which time the lake had been filling for probably the best part of a year and was 5 miles long by half a mile in width and its surface level was rising by several feet a day, a rapid rate due to the melting of the snow and ice in the glaciers above. Crookshank had made arrangements to photograph the final burst, and he attempted to make this occur at the hour of his choice by cutting a runway across the top of the dam. Some hidden outlet, however, suddenly gave and threw back his calculations by some 12 hours. Heavy rain and bad visibility prevented further attempts at regulation and the decisive breach occurred in pitch black night late on 25th August.

All that could be done was to listen to the roar of the escaping water and to watch the rapid extinction one by one of the tell-tale lanterns which had been arranged as an automatic record up the opposite hillside below the dam. Judging by these factors his opinion was that the whole dam had gone and he telegraphed to that effect and gave warning to " expect enormous flood."

The flood was indeed an enormous one, the river rising, for instance, 140 feet at a point about 50 miles downstream from Gohna. But in point of fact the whole dam had not gone. It had cut down to a depth of 390 out of its total height of 1,000 feet and the bed of the outflow had then solidified and resisted further cutting. A permanent lake was thus formed and so exists at the present time.

Crookshank gained much kudos and the thanks of the United Provinces Government for his conduct of affairs throughout. The most satisfactory features of the operations were that the Ganges Canal at Hurdwar was only slightly damaged (though the flood in actuality reached within inches of the top of the emergency cribwork), and that all loss of life was avoided except in the case of 5 persons, who in spite of all warnings refused to move from their hut immediately below the dam.

After the Gohna episode Crookshank was posted to a P.W.D. sub-division at Muttra but only served there for a few months as on the formation of the Chitral Relief Force he was claimed by the Military Department in March, 1895, for Field Service as Assistant Field Engineer at the Malakand. For this Campaign he was awarded the N.W. Frontier Medal and Clasp.

On return from Field Service in October, 1895, he was reposted to Muttra and shortly afterwards employed on cholera camp works in Bundelkhund and, in 1897, on famine relief works at Gorakhpur, for which he was again awarded the thanks of the Provincial Government.

From 1898 to 1900, in which latter year he was promoted Captain,

he was posted as District Engineer to Naini Tal, at which place he was employed on the building of the present Government House.

In 1901 he became District Engineer in the Lucknow District of the P.W.D. and thence went to England for a course at Chatham during 1904. On return to India he was promoted Under Secretary to the Government of India in the Public Works Department, United Provinces.

Although he had adopted the civil engineering branch of his profession he, throughout his P.W.D. service, took care to keep in touch with the military side, so far as possible, by Volunteer service, holding a company command in the Naini Tal Rifles while employed at that station and leading a troop of the U.P. Light Horse in the Allahabad Squadron in 1905-07.

In 1908 he became Executive Engineer of the King George's Medical College and Hospital Division at Lucknow and for the next 3 years was employed in a wide series of extensive designing and constructional works of much importance and interest, including two bridges over the river Gumti at Lucknow, the construction of the New Canning College at Lucknow, and of the Technical School of Design and the Arabic College at the same place, and of a large hospital in the native state of Balrampur. Throughout this period he was a Troop Leader of the Lucknow Squadron of the U.P. Light Horse. He was promoted Major R.E. in July, 1909.

In these various activities Crookshank and his work came conspicuously to the notice of that great administrator, Sir John Prescott Hewett, I.C.S., who was then Lieutenant-Governor of the United Provinces. Not only was Sir John much impressed by Crookshank's professional ability but the engaging personality of the latter so much attracted him as to lay the foundation of a personal friendship which continually increased throughout the subsequent years.

It may not be out of place to quote here from the address presented to the Lieutenant-Governor by the Committee of the New Canning College, referred to above, at the opening ceremony :—

"The Committee are specially grateful to Your Honour for entrusting the complete specification, the inception, and the progress of the greater part of the work to Major S. D'A. Crookshank, R.E., whose brilliant talents, unswerving resolution, and indefatigable energy have created the inseparable association of his name with the New Canning College building."

It will be noted that much of Crookshank's work in these years lay in the province of the design of important buildings. In this connection it may be opportune to refer here to his artistic talent. Although he was always too busy a man to be able to devote much time to art as a pastime, he was naturally endowed with an eye for effect and a cleverness of touch which made him an architectural draughtsman of a very high class. And it was to the possession of

this talent as well as to his width of vision that he owed a large share of his success as a designer.

The Coronation Durbar at Delhi in 1911 provided the next opportunity for the exercise of his capabilities. Sir John Hewett was selected by the Viceroy as supreme organizer and director of the Durbar and all connected with it and he in turn placed Crookshank in complete charge of all the engineering works concerned. "A truly marvellous experience" as Crookshank himself described it. It may be mentioned that the Durbar camps and arena covered an area of over 25 square miles. The preparations occupied 12 months and the brilliant success of the ceremony as a whole is a matter of history. For his services Crookshank received an immediate award of the M.V.O., followed in 1912 by the C.I.E.

On his return in 1913 from leave to England he renewed his acquaintance with Delhi by being selected for duty in connection with the construction of the Imperial Capital at New Delhi, with the grading of a Superintending Engineer. Sir Hugh Keeling, the well-known Civil Engineer, who selected him, writes :—

"..... He was kind-hearted and always ready to give a lame dog a helping hand. He was full of drive and no one was better at getting a job of work done. He saw to it that his young men worked hard and played hard. . . ."

In the latter connection it may be mentioned here that Crookshank was always a keen sportsman. So far as his devotion to duty permitted he joined, as a good Sapper should, in as wide a variety of sport and games as possible. He got much pleasure out of polo, pigsticking, shooting, golf and, in later years, salmon fishing.

He became a Squadron Commander of the Punjab Light Horse while at New Delhi.

Somewhere about this time he observed to the writer "I suppose I shall now go on building New Delhi until I retire." But 1914 changed all that and on the 11th November of that year he was given command of the Field Squadron R.E. of the 2nd Indian Cavalry Division in France. In July, 1915, he was appointed C.R.E. (temporary Lieut.-Colonel) 47th (2nd London) Division and was present at the battle of Loos in September. When the Germans attacked at Vimy Ridge in May, 1916, and captured the summit, he organized a defensive line with his Sappers. He was awarded the D.S.O. shortly afterwards. During the battles of the Somme he was with the Division at High Wood in September and at Transloy in October.

In November, 1916, he was appointed Deputy Director of Light Railways in France and in January, 1917, Chief Engineer XV Corps which appointment however he was soon to leave on selection in March, 1917, as Deputy Director-General of Transportation, the new department recently created, embodying many civilian experts

under Sir Eric Geddes and Sir Philip Nash. Crookshank became one of the former's three Deputy Directors, as a temporary Brigadier-General. He was promoted substantive Lieut.-Colonel in June, 1917.

In May, 1917, Sir Eric Geddes left France to go to the Admiralty and Sir Philip Nash succeeded him as Director-General of Transportation, which appointment carried with it the right of direct access to the C.-in-C. independent of the Q.M.G. Sir Philip in his turn was transferred in December, 1917, to the Inter-Allied Transportation Council and this meant a further step for Crookshank, who became acting D.G.T. in his place and he was confirmed as D.G.T. in March, 1918, with the temporary rank of Major-General. (He received the brevet of Colonel in January, 1918.)

As Director-General he was directly responsible throughout the area of British occupation on the Western Front for all railways, light railways, dock working, inland water transport, construction and maintenance of roads, and for the Transportation services which co-ordinated the use by the army of all these forms of transport, the total personnel comprising at its peak 162,500 men. He shouldered these heavy responsibilities throughout all the stress of the great German offensive in March and April, 1918, followed by the turn of the tide culminating in the final victorious advance of the Allies. And he continued in the post until May, 1919, being promoted substantive Colonel in June, 1919.

His war services were mentioned seven times in despatches ; he was created C.B. in 1918, and K.C.M.G. in the following year. He was also awarded the French *Croix de Guerre* (*avec palmes*), the Belgian *Croix de Guerre*, and the Distinguished Service Medal of the U.S. Army, and was made Commander of the Order of Leopold, Commander of the Legion of Honour and Grand Commander of the Order of Avis of Portugal. In 1920 he was made, in recognition of his responsibilities with regard to the ambulance train services, a Knight of Grace of the Order of St. John of Jerusalem.

As regards his services as D.G. Transportation, Sir Sam Fay, who was at that time Director-General of Movements and Railways at the War Office and a member of the Army Council, writes, " He was, as one of those officers serving under him in France—a war-time military man—said ' A great gentleman.' That was the view of all of all of them without exception. . . . Haig, as you see from his letters to me quoted in my book, held him in high regard and he expressed in a talk to me his gratitude for Sir Sydney's work during and after the break through. . . . Of all those who served in the Transport Services during my period of office no one impressed me more than he did as a keen, clean and conscientious leader in word and deed." High praise indeed from one who was by virtue of his position in touch with every side of the transportation problem.

After only 4 months' leave Crookshank returned to India in

September, 1919, to take over the appointment of Secretary in the Public Works Department and Consulting Engineer to the Government of India, thus attaining to the highest appointment in the service which he had first joined 28 years before. As Secretary to the P.W.D. he became a member of the Viceroy's Legislative Council and a member of the Legislative Assembly. In the latter capacity he was seldom called upon to speak in the Assembly, as controversial subjects were outside his province—in such speeches as he did make his main theme was advice to the Indian legislator to learn to walk before he tried to run.

Throughout his term of office he commanded the Simla Rifles, a unit of the Auxiliary Forces of India.

On the abolition of his post, on reorganization, in 1923, he was deputed for special duty under the Colonial Office to report on the Public Works Services of the Gold Coast, after which he was appointed Chief Engineer of the Southern Command at home. His G.O.C.-in-C. at that time, Sir Alexander Godley, writes of him, "Coming as he did from high appointments in India, his efficiency and value to the Command were beyond question. But the great success he made of the appointment was due not only to this but even more to his delightful character and charm of manner. No trouble was too great for him to take for any of us and his cheery ways were a tonic for all with whom he came in contact. For him difficulties were only made to be overcome and I have never served with anyone more successful in surmounting them. We all loved him."

He retired from the Army in 1927 with the honorary rank of Major-General. For 4 years up to 1929, he was Hon. Colonel of the 47th (2nd London) Divisional R.E. (T.A.).

He was a member of the Council of the Institution of Royal Engineers, an Associate of the Institution of Civil Engineers and a member of the Council of the Institution of Engineers (India).

He was promoted Colonel Commandant R.E. in 1936, an award which gave him, such was his love for the Corps, possibly more pleasure than any other of his many distinctions.

After his retirement from the service in 1927 he became General Secretary of the Officers' Association, which appointment he filled with conspicuous success until failing health drove him out of harness some 10 months before his death in August last.

As regards his work for the Association the following speak for themselves. General the Hon. Sir Herbert Lawrence, C.G.S. to Earl Haig in France, writes of him—" . . . . His great chance came in the last war when he became Director-General of Transportation in 1918. It was here that I was fortunate enough to meet him and was able to appreciate the invaluable work which he did in the anxious months of March and April, and again in the victorious

months from August to the end of the war. His energy and vitality were tremendous factors in the accomplishment of his difficult task of keeping our communications open and his services were highly appreciated and valued by the late Lord Haig. As General Secretary of the Officers' Association he displayed his usual organizing power and tact, as thousands of officers to-day can testify who benefited by his work. He is a great loss to his friends and to the country, and he leaves his own monument behind him in his record of service to the nation and to his brother officers."

And as a further appreciation of his work for the Officers' Association the following extract from a letter from its Chairman, Colonel Sir Frank Watney, may be quoted :—

" There never was a wiser and kinder man to work with. . . . He was a great organizer and a great worker but above all he was so human and so full of love for those of his profession who were in want. . . . He not only saved the Association much money but was instrumental in obtaining for it many donations and subscriptions . . . . There never was an office which ran with so little friction and we all at 8, Eaton Square loved him. . . . "

In 1919 Crookshank married Beryl Mary, the youngest daughter of the late Commander Willoughby Still, R.N.. King George V and Queen Mary presented the bride and bridegroom with signed copies of their photographs.

There never was a happier marriage. Each was entirely devoted to the other. They shared all interests in common. They were ideally happy together in their charming home at Fleet, which it gave them so much pleasure to design and beautify and where they were so well-loved for their wide interest in local affairs. It is an unspeakable tragedy that they were not granted a more liberal space of time in which to enjoy their great happiness.

Lady Crookshank was a perfect companion and helpmate to her husband for 22 years. Her care and devotion throughout his fatal illness are beyond description.

They had no child. But Sydney had the great satisfaction of seeing the family name carried on in India by his nephew Arthur (mentioned above as being now a Major in the Scinde Horse), whom he saw through his Sandhurst days and the early years of his Army service and for whose entry into the Indian Cavalry he arranged, as a token of his own regard for India and the Indian Army.

In looking back on one's long personal friendship with Sydney Crookshank and in studying his outstanding career, the qualities which seem most closely to characterize him were his well-balanced judgment and his coolness and imperturbability. Added to these were a becoming measure of self-reliance and assurance and an invaluable sense of humour. He was generous and kind-hearted and, as is copiously evidenced in the record above, was possessed

of the power of gaining the trust and affection of all those with whom he worked, both superiors and subordinates.

His friendships were deep and widespread. In the many letters received concerning him there is a practical unanimity in referring to him affectionately as "Crookie."

His devotion to duty is fittingly attested by his favourite quotation :—

"We are not here to play, to dream, to drift.
We have hard work to do and loads to lift.
Shun not the struggle—face it—'tis God's gift."

W.H.B.

BRIGADIER-GENERAL J. H. TWISS, C.B., C.B.E.

JOHN HENRY TWISS was the son of Lieut.-Colonel Godfrey Twiss, R.A., and was born on 12th June, 1867. He was educated at Stubbington, a well-known preparatory school near Fareham and later at Portsmouth Grammar School and was gazetted to the R.E. from the Royal Military Academy on 16th September, 1885, in the rank of Lieutenant. In the autumn of 1888, on completion of his courses at the School of Military Engineering, he elected for Indian service and joined the Bombay Sappers and Miners at Kirkee. After a short time on the defence works at Bombay, he left for Aden with the 4th Company, Bombay S. and M. On return to India in 1890, he joined the railway service as Assistant Engineer, being employed on the Zhob Valley railway survey and also at Quetta and Bareilly. In 1892 he became Assistant Engineer of the State Railways at Moradabad. He was promoted Captain on 1st April, 1895, and returned home the same year, when he was given the command of the 8th Railway Company at Chattenden. In 1899 he went to China for six months on special duty, but was back in time for the outbreak of the South African War, when he was one of the group of R.E. officers with railway experience who were selected by Girouard to form a Military Controlling Staff for the local railways.

One of the first steps taken by Girouard was the formation of two field railway sections to repair the railway lines as the troops advanced. Twiss was put in charge of the Midland Field Section, with headquarters at Naauwpoort, working on the railway to Norval's Pont. He was given the local rank of Major and graded as an Assistant Director and had under him the 10th (Railway) Com-

Brig-Gen John Henry Twiss CB CBE

pany and the 20th and 42nd (Fortress) Companies R.E. At first these Sections had to control the traffic at railhead as well as carry out repairs, but it was soon found better to leave all the traffic in the hands of the regular staff and these Sections became construction parties carrying out repairs only. When Lord Roberts occupied Bloemfontein in March, 1900, the line from Norval's Pont was rapidly put in a state of repair and in 13 days a train ran through to headquarters.

As soon as the Director of Railways was established in Bloemfontein he brought Twiss into his office as Chief Staff Officer and when in June the Director moved to Johannesburg, Twiss accompanied his chief and remained there until the end of the operations. He retained his local rank of Major and was graded as A.A.G.

For his services during the war, Twiss was mentioned in despatches, and given the brevet of Major, 29th November, 1900; he received the Queen's Medal with three clasps and the King's Medal with two. On returning home, Twiss joined for duty in the office of the Inspector-General of Fortifications in Whitehall and in 1903 was acting A.D.C. to the Inspector-General, Major-General Sir William Shone, but unfortunately for Twiss his chief came under the ban of the Esher Committee in 1904 and Twiss lost the appointment. He had been promoted Major on the regimental list on 26th May, 1903, and at the end of 1904 left for a second tour of service in India, which lasted five years. During this time he was successively officiating C.R.E. at Madras and at Ahmednagar, in 1907 he was Assistant C.R.E. Lahore and in 1909 became Garrison Engineer, Peshawar.

Returning home in 1910 he went for a short time to Gosport and was then posted to the Training Depot for Field units, Aldershot. On promotion to Lieut.-Colonel on 1st April, 1911, he was made C.R.E. Lands District, Aldershot, but left there the same year on appointment as C.R.E. Longmoor and O.C. Railway Companies, Longmoor Camp.

During the period from 1906 the newly-formed General Staff at the War Office was busy in preparing an organization for the Expeditionary Force of six Divisions and one Cavalry Division. Among other details, a scheme was prepared for a line of communications, consisting of a Base, connected by a line of Railway with an Advanced Base and with a road service from the Advanced Base to G.H.Q. of the Force. The details were embodied in *Field Service Regulations*, which included instructions for the working of the Railway service. At the beginning of 1913 the scheme was sufficiently crystallized to enable the staff to distribute appointments as Directors of the various services, when Twiss was given the dormant appointment of Director of Railway Transport with the Expeditionary Force; he then commenced a study of continental methods of working railways in war.

Under the proposed organization, the Directors of Services came under the orders of an officer called the Inspector-General of Communications, who was to be stationed at the Advanced Base. But the general control was to be retained by the General Staff, though the Adjutant-General and the Quartermaster-General were to have control of the work of certain Directors, the latter controlling Railways as well as all other Engineer branches, except Signals, which remained under the General Staff.

Though it was well known that the war for which these preparations were made was in alliance with France against Germany, the actual details of Bases and of the area which the British Force was to occupy were kept very confidential and the detailed arrangement for the landing and movement of the troops were discussed by the General Staff direct with the French Headquarters. The latter had worked out a very complete system of Railway control, which, they were insistent, should not be interfered with by local Military Officers and it was laid down that all communications with the French Headquarters should be made through an officer of the General Staff (G.S.O.2) on the staff of the I.G.C.

But the French, in the course of these conversations, undertook to carry out all the Railway movement for the British Force as well as undertaking the preparation of all engineer services, such as the arrangements for landing at the ports, and the entraining of the troops, also the provision of all rest camps. In fact they proposed to treat the British Force as simply two corps of their own much larger army. Under this arrangement, which was accepted by our General Staff, most of the duties laid down in our *Field Service Regulations* for the Director of Railway Transport were to be carried out by officials of the French Railways. When war actually broke out it was therefore decided that a Director of Railway Transport was not required in France and Twiss, while retaining the appointment, was ordered to remain in England to " prepare for expansion " and to study the question of the reconstruction and use of the Belgian Railways.

The whole story is told in *Transportation on the Western Front*, compiled by Colonel A. M. Henniker with an introduction by Brig.-General Sir James E. Edmonds, which forms one volume of the *Official History of the War* and most of the facts in this memoir are based on that publication. It is only possible here to mention such facts as bear directly on the subject of this memoir.

The only representative of the D.R.T. to embark with the troops was one Assistant Director (Lieut.-Colonel Henniker) but there were also six Deputy Assistant Directors, who were detailed to the Base Commandants at the various Bases and also 24 R.T.O's for duty in pairs at the twelve contemplated detraining stations. These arrangements had been worked out in detail in the

Directorate of Military Operations at the War Office by Major R. M. Johnson, R.A., and this officer became G.S.O.2. of the I.G.C.

The ports selected for disembarkation were Havre as the main Base, with Rouen as an auxiliary, and Boulogne, which was only to be used for the first landing of the troops. The Advanced Base was Amiens, which became the headquarters of the I.G.C. and the main regulating station for the distribution of troops and supplies. The railway line from Havre to Amiens was the main line for the British Force.

Under this scheme this Force was successfully moved to the positions selected for them in the neighbourhood of Mons, but there was some friction owing to the want of R.T.O's at the bases to act as intermediaries between the British and French. The latter were then, as always, most anxious to help but the methods of the French, with low platforms necessitating loading of vehicles by ramps, the use of unfamiliar types of rolling stock and the fact that the instructions were in a foreign language which few could understand, caused a certain amount of cross purposes and when, a few days later, the retreat from Mons began, a situation followed which Henniker describes as a nightmare. He adds "only by putting French-speaking officers on the trains were supplies and other requirements got through to the troops to ever-varying railheads."

The abandonment of the Channel Bases and the transfer of St. Nazaire added to the difficulty, and the advance after the battle of the Marne presented the new problem of the reconstruction of the damaged railways and bridges.

Meanwhile the Q.M.G. at the front, who had the responsibility of instructing the I.G.C. as to the stations selected for the detraining of troops and supplies in the fighting area, found the necessity of expert advice and as early as 20th August asked for the services of the A.D.R.T. at G.H.Q. The I.G.C. was however unable to spare this officer but, a few days later, Major Johnson, the G.S.O.2, was sent for to G.H.Q. and remained there.

In September, the I.G.C. sent for Twiss to discuss the question of the repair of the damaged railways and the D.R.T. came out for about a week, during which he established a traffic branch for the L. of C. and obtained a much needed increase in the number of the R.T.O's to a total of 75.

At the beginning of October the Channel Ports were reoccupied and the headquarters of the L. of C. moved to Abbeville in the middle of that month. The ports of Havre and Rouen were still the principal bases but the port of Boulogne was taken into use again, owing to its proximity to the British armies round Ypres.

In the same month Lord Kitchener sent Brig.-General Sir Percy Girouard to France to report on the railway situation; Girouard was

accompanied by Twiss and by Lieut.-Colonel V. Murray, who had recently arrived from India.

Girouard's report covered the whole ground of the relations between the French and English and among his conclusions was the recommendation that the full control of British railway traffic should be at G.H.Q., where the D.R.T. should be stationed. This was approved at once and Twiss for the first time assumed his proper function as D.R.T. at headquarters. Colonel V. Murray also remained in France as D.D.R.T responsible for Railway Traffic and Major R. M. Johnson became A.D.R.T. under him. The I.G.C. was thus relieved of all responsibility for the control and co-ordination of Railway Traffic.

The future history of the Railway service in France describes the gradual transfer to the British of responsibility for the railways used by them, not only for repair and maintenance, but for the provision of sidings, watering points for locomotives, new spur lines to feed store and ammunition dumps and new connecting lines to facilitate cross traffic, and also later for the supply of wagons and locomotives and personnel to operate the trains.

Twiss's first job after forming the Traffic branch was the formation of a construction branch under a second D.D.R.T. At this time the British had two companies of R.E., the 8th and 10th, which since the days of the Egyptian campaigns of 1882 and 1886 had specialized in Railway work ; both of these were mobilized and the 8th Company had proceeded to France in August, 1914, but at first no work could be found for it ! It was joined in November by the 10th Company. There were also in England one company each of the Anglesey and Monmouthshire Special Reserve R.E. who had a railway training at Longmoor each year, but there were no railway units among the Territorials, an efficient railway unit at Crewe having been broken up for financial reasons in 1912 on the advice of a War Office Committee, of which Lord Kitchener himself had been Chairman ! The decision to employ British Railway Engineers in France necessitated the formation of a Stores Branch to supply tools and materials. By May, 1915, the number of British construction companies in France had risen to ten and there were four more in process of formation for future use in Belgium.

Another branch which soon became necessary was a Railway Operating Department (R.O.D.), at first formed for work on the Belgian Railways but later very useful for operating shunting engines in store yards and on branch railways.

In December, 1914, the D.R.T. was made also responsible for the Inland Water Transport under a Deputy-Director.

Twiss also had to organize the business side of his office. He appointed a Railway Accountant to deal with the many financial questions which arose, and to check bills sent in by the Nord

Railway, which was a commercial company. There were also many questions of detail to handle, such as the issue of railway warrants for passage on military trains, the carriage of the mail, the circulation of newspapers and the transport of parcels. For all these a headquarters office for the D.R.T. developed near G.H.Q., first at St. Omer and from March, 1916, at Montreuil.

Twiss came out to France with the rank of Colonel but in November he was given the rank of Brigadier-General. In October, 1915, the title of his appointment was changed to Director of Railways, but at the same time he was relieved of the responsibility for the Inland Water service, which was made independent under its own Director.

The expansion of the British Armies and the beginning of trench warfare produced many difficult problems. Just as in England all the larger railways radiate from London, so in France all the railways run into Paris; the movements from Havre to the armies in the north-east were thus across the general line of the railways, involving the use of branch lines and inconvenient connections. Also additional ports were taken into use. In November, 1914, Dieppe was taken and in May, 1915, Calais, which had been originally allotted to the Belgians, was divided between the Belgians and the British. The port of Boulogne had only limited facilities and was very congested, large extensions were made both of wharf and rail facilities and later, Dunkirk was used to relieve Boulogne and Calais and became the principal port of entry for railway stores. The question of "regulating stations," or centres where the various bulk trains of goods were divided to make up the daily mixed supply trains sent to the front, also involved much care and thought.

By April, 1916, the British were formed in four Armies; the Second Army in the north was based on Calais, with a regulating station just outside that town, the First Army which came next in the line was based on Boulogne, with its regulating station at the Docks. The Third and Fourth Armies, which continued the line to the neighbourhood of Albert, were based on the southern group of ports—Havre, Rouen and Dieppe, with a regulating station at Abbeville for the Third Army and for the Fourth Army at Abancourt. The latter centre was also used for the Fifth Army when the line extended south of Albert.

When the warfare became stationary, store depots or dumps had to be constructed at or near railhead, where accumulations of ammunition, engineer stores and supplies could be collected. By April, 1916, over 70 such dumps had been formed, each requiring a series of railway sidings and giving work to the R.O.D.

A further problem was the provision of tactical lines in connection with operations and the formation of tactical trains, to be held at selected centres ready to transport troops during operations.

Edmonds, in the introduction already referred to, notes that, during 1916, 55 miles of standard gauge railway, including 20 miles of sidings, had been built in preparation for the battle of the Somme and the total of full size track built for the whole B.E.F. had reached 417 miles. By the end of 1916 the strength of the R.O.D. had grown to 5,419, the total of officers on the railway transport establishment had reached 280 and the number of railway construction companies had risen to 22. These figures are quoted as giving some measure of the size of the organization which had grown up in two years under Twiss's care and supervision.

But this was not enough, the British use of railways for military traffic more than doubled during 1916, while the French railways were suffering from wear and tear of locomotives and railway stock and reduction of personnel, so in February, 1916, the French asked for help and 2,500 wagons were ordered from England. Also the want of railway facilities caused congestion at the ports, so that shipping was delayed, while the roads at the front were beginning to break up.

At the end of August, 1916, Sir Eric Geddes of the North Eastern Railway was sent to France to investigate. It was decided on his report to create a single authority at home and for the B.E.F. and in September, Sir Eric was appointed Director-General of Military Railways at home with control of all canals, docks and roads, and in January, 1917, he was made a member of the Army Council; in October, 1916, he was also appointed Director-General of Transportation of the British Armies in France, directly responsible to the Commander-in-Chief and independent of the Quartermaster-General. He took over not only the Directorate of Railways, but also Inland Water Transport, Docks, Light Railways and Roads, each group under a Director, and formed a very large staff, mainly drawn from civilian engineers and railway officials, who were given military rank, Sir Eric himself becoming a temporary Major-General. He opened a great central office to contain 100 officers and 600 other ranks, for whom a range of huts was constructed at a place called "Geddesburg," about 3 miles from Montreuil. From his position as Dictator he was able to obtain a large increase of personnel from home and also railway and road making plant, 1,200 miles of some of the smaller railway lines in England were ripped up and transported to France, while he obtained in all 54,000 wagons and nearly 700 locomotives. With these large extensions he succeeded in "delivering the goods."

It is doubtful whether any military officer, in the temper of the Government and public at the time, could have carried out such a reform, but it was unfortunate that no place could be found for Twiss in the new organization. There was, of course, up to this time no official record of the two years' work of the Railway Directorate

and in view of the urgent need for expansion the good work done in the past was overlooked. Also Geddes, realizing the technical help needed on the French railways, was anxious to obtain the services of some of the experienced railway engineers from the English railways, so in his final staff the only military Director retained was Colonel V. Murray, who became Director of Railway Traffic, with a military staff under him.

All through the war years, Twiss had been looking ahead and constantly pressing for expansion, but the headquarters of the Armies were not Railway-minded and the same may be said of the Government at Home. Again quoting Edmonds—transportation demands from France had met with such answers as " the Board of Trade say that rolling stock cannot be spared," " the Ministry of Munitions will not allocate steel," or " the man-power situation does not admit."

The work that Twiss had done had been recognized in France by a mention in despatches and the grant of the C.B. in October, 1915, and also by his appointment by our Allies as Commander of the Legion of Honour and Officer of the Order of Leopold, but this did not prevent Twiss feeling a deep sense of disappointment at being unable to continue his work in France.

He was also unfortunate in the time of his return to England. He had completed five years on the regimental list of Lieut.-Colonels on 1st April, 1916, and had been placed on the Colonel's list with an ante-date to 15th December, 1914, but there were no appointments vacant for Engineer Colonels. He was therefore offered and accepted an appointment as C.R.E. Brighton, in February, 1917, in place of a retired officer, and remained there until he retired on 1st May, 1921. The appointment at Brighton included the whole of the County of Sussex and the work included the defences and large A.S.C. centre at Newhaven, three large groups of hutments at Seaford, Shoreham and Crowborough, each originally constructed for a Division, but used as convalescent and training camps, a large aerodrome at Shoreham, masses of hospitals in Brighton and Chichester, troops in billets at Hastings and many smaller centres in the country—a full time job, but not of course equal in importance to what he had relinquished. At the end of the war his good work was more fully recognized and he was given the C.B.E. in the final honours list in 1919. Also it may be noted that Sir Eric Geddes, speaking after the war, of what he himself had been able to accomplish, said " the old Director of Railways never had a chance." He might have added that the work of Twiss as Director of Railways had been the foundation of the larger organization formed by himself, all the essential details, such as selection of bases, route of supply lines and selection of regulating points, were continued practically unchanged, and without this preliminary work, Geddes' extension would have been much more difficult.

Twiss was one of the class of quiet, self-effacing workers of which the Corps produces so many. He was successful in getting round him a group of competent officers with railway experience, most of whom had been his colleagues in South Africa and was content to let them carry on, with the minimum of interference from headquarters. Such a method of working is very gratifying to the subordinates, but may not impress an observer from outside.

One of his early friends writes of him as a charming companion and a good fellow.

Twiss was very keen on all games. In his early days he played cricket for the Shop and also for the S.M.E. and took part in some Corps matches ; he retained his interest in the game and was a member of the M.C.C. and Free Foresters to the end of his life. The writer also remembers him as a very efficient goal keeper in the foot-ball team at Chatham from 1885 up to his departure for India. In his later days he became a leading official of the Croquet Association, was their official handicapper for several years up to September, 1939, and kept the record of matches and tournaments.

He passed away at Camberley on 29th July, 1941, at the age of 74.

He married at Ootacamund in February, 1906, the daughter of Major-General A. T. Searle of the Indian Army, who survives him ; they had one daughter, now the wife of L. H. Twiss, Esq.

W.B.B.

BRIGADIER-GENERAL J. W. S. SEWELL, C.B., C.M.G.

JONATHAN WILLIAM SHIRLEY SEWELL was born at Headcorn, Kent, on 3rd October, 1872 ; he was the son of the Rev. H. D. Sewell, M.A., who had come over to England as a young man from Quebec. Sewell was educated at Monckton Combe and at the Royal Military Academy. He was gazetted 2nd-Lieutenant R.E. on 24th July, 1891. After the courses at the S.M.E. he was selected for training in Submarine Mining at the School at Gillingham, with a rough water course at Gosport in the summer of 1893. On completion of this he was posted to the 4th Company at Fort Monckton, Gosport. This station in 1892 had been made the headquarters of a new School of Submarine Mining, with Captain W. Sealy Vidal as the Chief Instructor ; the staff of the school were also responsible for the mining and electric light defence of the eastern entrance to Spithead and Portsmouth, including the defence of Southampton Water at Calshot Castle. Sewell assisted in the instruction of classes on the water. In the autumn of 1894 Vidal went sick and during his

Brig-Gen Jonathan William Sewell CB CMG

absence the work of Chief Instructor devolved on the Assistant Instructor (Captain W. Baker Brown) and Sewell was temporarily appointed as Assistant. This temporary staff remained in charge until September, 1895, carrying out the annual two months' training with the local Militia in January to March. There was also in hand a revision of the mining defences of Portsmouth and Calshot and a large addition to the electric lighting defence of the whole of the eastern entrance of Spithead between Eastney on the mainland and the Isle of Wight. Sewell took charge of the officers' class that summer and carried out the work required with his usual efficiency.

At the beginning of 1896 he was ordered to the 6th Company at Gibraltar, where a new scheme of electric light defence was contemplated. The internal-combustion oil engine was just being introduced into the service and the trials of the first engines of this type had been carried out at the S.M. School, Gosport, during 1894 and 1895. In 1899, on the outbreak of the South African War, the 6th Company was ordered to the Cape for duty on railway construction. It was employed on the main line to Pretoria and did good work in the repair of the big bridge at Vereeniging and other repair work during 1900. In 1901 Sewell was appointed Superintendent of Railway Cartage and later became Personal Assistant to the General Manager at Johannesburg. He received the Queen's medal with three clasps and the King's medal with two.

After the war came to an end Sewell remained in South Africa, one of the group of R.E. officers who were retained by Lord Milner to assist in carrying on the government, and continued in his appointment as Personal Assistant to the General Manager, Central South African Railways. He was promoted Captain on 1st June, 1902.

When South Africa was granted self-government at the end of 1904 the R.E. officers were withdrawn and Sewell was sent to Chatham, where he commanded, first "G" Depot Company and then the 8th Railway Company at Chattenden. In 1906 he was appointed Superintendent of Workshops at the S.M.E. Up to the end of the S. African War these workshops were used for the employment of N.C.O's and men in the various companies at the S.M.E. and were under a junior officer, graded as Assistant Instructor. But in 1901, when Captain J. N. C. Kennedy was put in charge, there was a large development of mechanical transport in the Army, and when it was decided to place this under the A.S.C., the first A.S.C. Companies were trained by Kennedy in the Chatham shops. Also, in the re-arrangement of R.E. units which followed the Esher Committee in 1904 and 1905, one of the few Fortress companies which survived—the 29th—was posted to Chatham for duty in the workshops and allotted to the L. of C. of the Field Army on mobilization. Sewell, on succeeding to this appointment, thus found the

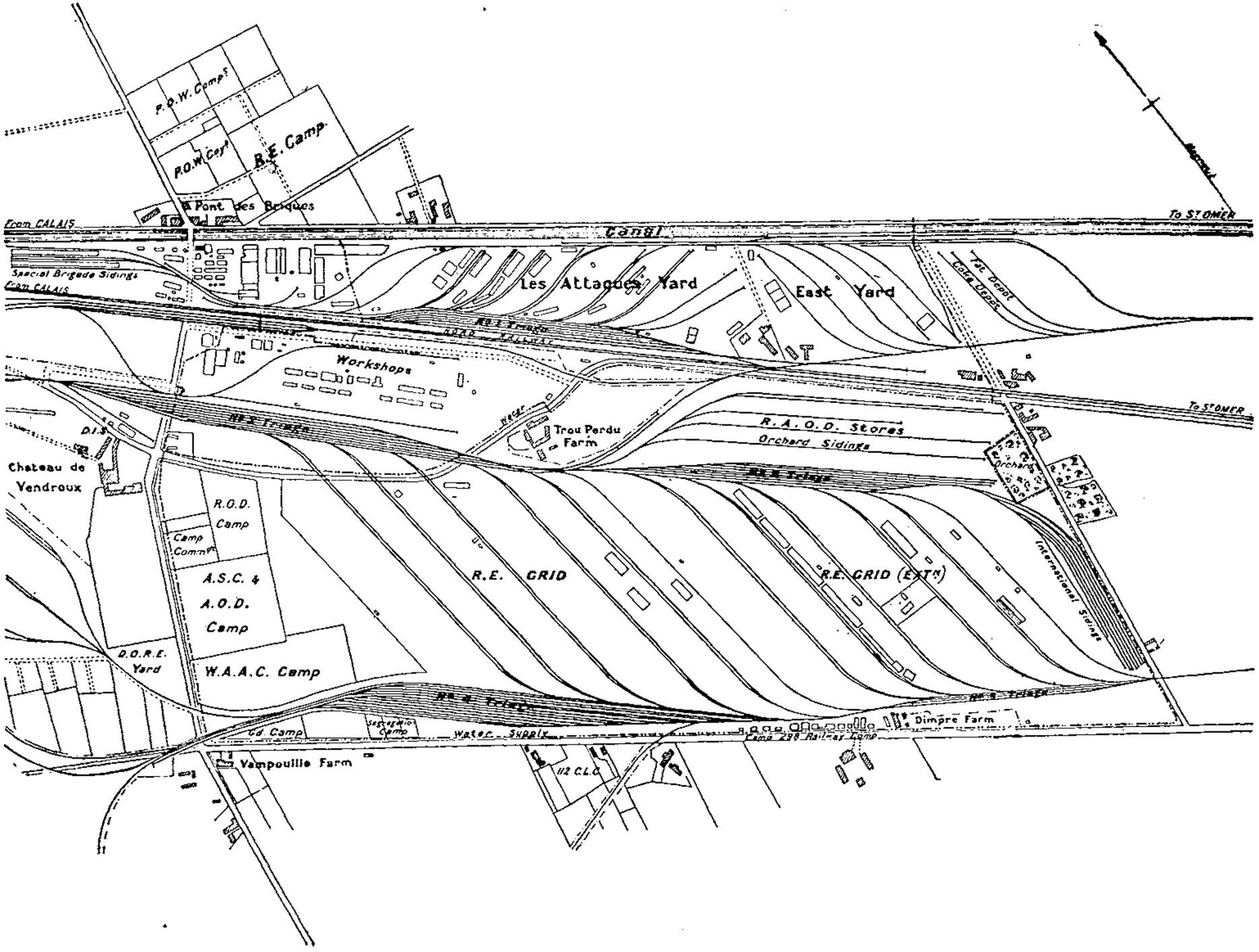
whole organization in a state of transition, and a small unit at hand, and was able to re-arrange and rebuild many of the old workshops and re-model the instruction. His work was recognized by his appointment as Instructor in Workshops.

In 1910, he was ordered abroad to command the 1st Company at Gibraltar. The electric light defence of this station had increased largely since he had left there in 1899 and, as Electric Light Officer, he contributed materially to the improvement of the defences. He was also in charge of the telegraph and telephone work of the fortress and Inspector of R.E. Machinery. In this latter capacity he had the important work of installing refrigerating machinery for the storage of meat and in 1911 was sent to Malta for a short time to advise on the installation of similar machinery at that station. He received his promotion to Major on 24th July, 1911, on completion of twenty years' service.

On the outbreak of the European War he was still at Gibraltar in charge of the electric light defence and when, after the first few months, officers and men began to be withdrawn from stations abroad, he acted for a time as D.A.A.G. In March, 1915, the 1st Company, with Sewell in command, was ordered to join the British force in France and was posted to Calais, where Sewell began his long connection with the supply of R.E. stores for the Armies, of which he was later made Director.

The 1st Company had been given the establishment of an Advanced Park Company and should have gone to a forward area but just at this time the port of Calais was being opened for use by the British and the 1st Company was ordered to take charge of the store work at that station. Sewell arrived at Calais in May, 1915, and got a berth allotted at the " Basin Carnot " with a shed on the quay and a small store nearby. He shared with Boulogne the landing of stores required by the Armies on the Northern Front. But within a few months the berths at Boulogne were reclaimed by the French and berths at Dunkirk were allotted in their place, so that, by the end of 1915, Sewell had the whole responsibility for the supply on the northern portion of the L. of C. Although he had had no experience of store work before he arrived in France, he threw himself into the job and soon established friendly relations with the other officers at the Base and also in the Armies supplied by him.

In October, 1915, a storeyard was opened at Calais to receive stores which were not immediately required at the front and Sewell was able to secure a very good site at Les Attaques, about three miles from Calais. The site was bounded on one side by the Nord Railway, from Calais to St. Omer, and on the other by the Canal system which connected Calais and Dunkirk with the area occupied by the British Army. It was about 50 acres in extent and, after setting aside an area for workshops and hutments for the company, was covered by


P.O.W. Camps
P.O.W. Coys
R.E. Camp
Pont des Briques
From CALAIS
To ST OMER
Canal
Special Brigade Sidings
From CALAIS
Les Attaques Yard
East Yard
Fat Depot
Coke Depot
Workshops
To ST OMER
R.A.O.D. Stores
Orchard Sidings
Trou Perdu Farm
Château de Vendroux
R.O.D. Camp
Camp Comdt
A.S.C. & A.O.D. Camp
W.A.A.C. Camp
D.O.R.E. Yard
R.E. GRID
R.E. GRID (EXTN)
International Sidings
Cd Camp
Water Supply
Camp 298 Railway Camp
Dimpre Farm
Vampouille Farm
112 C.L.C.

a grid-iron of railway lines connected to a *triage*, or marshalling yard, whence trains could be despatched by the Nord Railway. A workshop was started in January, 1916.

Army G.H.Q. was at this time at St. Omer, and Sewell was frequently consulted by the E.-in-C.'s office, not only on Stores questions, but on the details of Nissen huts and workshop machinery. When a separate Mining branch was formed, Les Attaques was made the depot of the mining plant, much of which was of an experimental nature. An unusual industry was the breeding of white mice and canaries for use in the mine galleries, eventually requiring the use of two huts and the attendance of two sappers. The growth of the Armies increased the length of the line held by the British, and the amounts of R.E. stores grew until at the end of 1916 about 90,000 tons were passing through the R.E. yards to the Armies every month, of which about half went from Les Attaques. Though Sewell had no direct hand in the organization and standardizing of the types of the stores, his suggestions and criticism were always useful. Among other things he suggested that some of the "B" men in the stations on the L. of C., who were at that time the only source of labour, should be formed into Store Sections, each of a strength of 3 officers and 100 men. Two such sections were approved and proved so successful that eventually 8 such sections were formed.

In July, 1916, the Director of Works divided the store organization into two parts, north and south, and Sewell was put in charge of the northern part, with the title of Chief R.E. Stores Officer (N) and was given the brevet of Lieut.-Colonel. At the same time the 1st Company was raised to the status of a Base Park Company (9 Officers and 227 Other Ranks), and about the same time the yard at Les Attaques was increased to about 65 acres.

In April, 1917, a very big scheme was started to construct at Calais a group of Supply and Ordnance depots. Sewell took great interest in this scheme, which was to be situated near the Chateau of Vendroux and close to Les Attaques, and when the lay-out was being arranged, succeeded in retaining an area for an extension of the R.E. store depot. This was a nearly level site on the opposite side of the Nord Railway from Les Attaques. A considerable area was reserved for shops and accommodation for personnel and the remainder was laid out with a large grid-iron of railway sidings and a *triage* for making up trains. With his experience of the smaller depot, Sewell was able to embody all requirements essential to quick working and the easy turn-over of stores. The addition of the new area raised the storage space to about 150 acres.

Partly from its situation near Army headquarters and from its size and general up-to-dateness, the whole group of depots was frequently visited by senior officers of the American and our own Armies, while groups of officers from England, visiting France to

get experience of the fighting, were taken on tour round the R.E. depot, where they were shown some of the details of mining and trench warfare and the methods of loading and despatch by rail and barge.

As the yard grew Sewell added new shops, until towards the end of 1917 he had a total of 422 artisans and 387 labourers employed in the wood-working shops, with 51 saws and 24 other machines, and in the metal workshops there were 403 artisans and 75 labourers, with 129 machines, forges and hearths.

The German advance in March, 1918, threatened the whole system of store supply, so the Engineer-in-Chief asked for the services of Sewell to take charge of the store work in his office. To supply the new defence lines under construction, Sewell arranged temporary dumps near Abbeville for the south line and at Teneur for the north line, from which troops could draw supplies of engineer stores by road. For a time the L. of C. worked in two separate parts, the northern half coming directly under the E.-in-C. at Montreuil, with Sewell as stores officer. When the German advance was finally halted, Sewell was employed to reorganize the Corps dumps for the northern Armies.

At the end of June it was decided that Sewell should succeed the present writer in charge of Engineer Stores ; in addition, he took over the work, formerly done by the Assistant E.-in-C. at G.H.Q. under the Deputy E.-in-C., of regulating the stocks of stores in the forward Corps dumps and with this added responsibility the organization was raised to the status of a Directorate and Sewell was given the rank of Brigadier-General. The new Directorate was made independent of the E.-in-C. and the D.W. and worked directly under the Q.M.G. The strength of the new Directorate was 108 officers and about 2,500 N.C.O's and men, made up of three Base Park Companies, 8 Store Sections, 2 Workshop Companies and a number of Prisoner of War Companies. In addition, about 10,000 men supplied by Labour organizations came into the depots for work daily. Besides the Vendroux depot there were base workshops and storeyards at Abancourt, Havre and Rouen, the total storage space for R.E. stores reaching 420 acres. The Directorate started with all its depots full and with all workshops in full work, orders for current stores had been placed for three months ahead and orders had also been sent home for 25,000 Nissen huts and extras for the winter of 1918-1919.

The subsequent work was rather disappointing for Sewell, as in August the British Armies began the series of operations which eventually led to the defeat of the Germans and the Armistice of 11th November. During these operations the demand for engineer stores fell off considerably, but Sewell was kept busy in reorganizing the Corps dumps at the front in case operations again became

stabilized. An important item was the distribution of the stock of steel bridges which had been accumulated for just such an emergency. This had been originally formed at Havre, but as soon as the enlarged depot at Les Attaques became available, about January, 1918, half of this stock had been moved forward and stored in the new depot. In addition, more steel work had been prepared in the base workshops. Bridges from both these bases were now sent forward and contributed much to the success of the operations.

By July, 1918, the G.H.Q. began preparations for demobilization and large rest camps were ordered at all the base ports, to be hutted if possible, where the troops on the way home could be deloused and supplied with clean clothing before embarkation. The replacement of tents by huts on the L. of C., which had been in hand since the middle of 1917, was continued right up to the Armistice and there was a demand for hutting for units displaced during the German advance in the spring. All the base shops were kept full of work, especially in the construction of a light form of sectional hut which Sewell had suggested and which he termed "sausage hutting" because it was measured by the foot run. About 180,000 feet run were constructed.

On the 7th April, 1919, G.H.Q. British Armies in France ceased to exist and Sewell came under the orders of the G.O.C. Troops in France and Flanders. His first job was to supply the wants of the British Army of the Rhine, but when the troops left he remained in France to carry out the disposal of the engineer stores and buildings they had left behind. He was employed on this work until May, 1921. The work was important on account of the amounts involved; he had to deal with the stores in the forward dumps and also some dumps captured from the enemy, and also all huts and stores on the L. of C. The R.E. stores in the depot at Les Attaques at the time of the Armistice were valued at four million pounds, so that the total handled must have been many times that figure. A civilian disposal board had been formed in England and Sewell was the intermediary between this body and the French Government. Many of the dumps and depots were handed over nearly intact to the French, who used the timber and huts in the *Région Libérée* to re-house the inhabitants, some of the Nissen huts were sent to Russia and much material was sold to English contractors, while special stores, such as bridges, were brought over to England for disposal. Sewell, who had opened an office in Paris, carried through the whole job very satisfactorily. In spite of some default on the part of the French, the amount realized mounted to several millions—a sum of nine million pounds has been estimated.

For his services during the war Sewell received the C.M.G. in June, 1918, and was made Brevet Colonel on 3rd June, 1919. Owing to his slow rate of promotion he did not reach the rank of Lieut.-

Colonel until 24th September, 1918, with 27 years' service, so on returning from France in 1921, he was made C.R.E. Dover, where he remained until he went on half-pay on 24th September, 1922. Owing to the congested state of the Colonels' list he had to wait on half-pay until, in January, 1924, he was made A.D.F.W. at the War Office.

On the conclusion of the war a change had been made in the organization of the D.F.W.'s office, where the two smaller branches formerly in charge of the Inspectors of Electric Lights and of Iron Structures were merged into one branch under a colonel. Sewell thus succeeded to the charge of what had become the Electrical and Mechanical branch of the War Office.

In 1927, he was appointed Chief Engineer, Malta, where he served until he retired under the age clause on 3rd October, 1929. His most important work at Malta was the construction of aerodromes for the Royal Air Force, which he carried out with his usual care and thoroughness.

Sewell was a stern disciplinarian and set a high standard for himself and others. At times he was inclined to "drive the willing horse" and seemed rather harsh in his criticism of subordinates. But those who obtained his confidence gave him the most devoted service, while he always took very good care for the welfare of all ranks under his control. His intellectual qualifications were of a high order and when he retired he interested himself in archæology, especially in the adaptation of astronomical calculations to the determination of the dates of early Egyptian and Babylonian history. In *The Times* of September 23rd, 1941, Mr. Sidney Smith, Keeper of the Department of Egyptian and Assyrian Antiquities, British Museum, bore witness to much interesting work of his which will, when published, correct the errors and misapprehensions to be detected in current archæological works for students. He also contributed to a pamphlet, *Alalakh and Chronology*, published last year by Mr. Smith and which the latter has kindly presented to the R.E. Library.,

On retirement Sewell settled at Aldeburgh, where he had a small yacht on the Broads, on which he was proud to fly the R.E. burgee. His house there was damaged in an air-raid in 1940, and with his wife he had to move to Crowthorne, Berks, where he developed an obscure disease of the heart from which he died on 10th August, 1941, at the comparatively early age of 68.

He married in 1896 the daughter of Rear-Admiral Orford Churchill, R.N., and leaves one son, who is now a Major in the Royal Artillery.

W.B.B.

LIEUT.-COLONEL SIR E. KEITH NUTTALL, BART., ROYAL ENGINEERS.

LIEUTENANT-COLONEL SIR EDMUND KEITH NUTTALL, Bart., was born on 27th March, 1901, and died in London on 31st August, 1941. He was educated at Brighton College and Clare College, Cambridge. His father died in 1923 while he was still at Cambridge and he succeeded to the title and became chairman of the firm of Edmund Nuttall, Sons & Co., Ltd., Civil Engineering Contractors, who, at that time, had their Head Office at Trafford Park, Manchester.

This firm was engaged in carrying out important civil engineering contracts, consisting of dock and harbour construction, reservoirs and tunnels, and similar civil engineering work. Sir Keith at once assumed an active part in the management of the Company, in spite of his youth and his lack of experience. Gradually, as he gained more experience and got a better grip of the engineering and business problems involved, he took more and more a leading part in the management of the Company that bore his name and which was founded by his grandfather.

In order to gain experience he spent some time on the construction of the Bartley Reservoir, which the firm was building for the Birmingham Corporation.

Just at this time the contract for the Mersey Road tunnel pilot headings was tendered for and Edmund Nuttall & Co. were successful in obtaining the contract, and, in fact, undertook the construction of the whole of the tunnel work with the exception of the Birkenhead approach. Sir Keith naturally took a great interest in all this work and used to spend a great deal of his time in connection with it. Another large contract which the firm carried out, jointly with John Mowlem & Co., was the construction of the King George V Dock at Southampton, which was designed to dry dock the *Queen Mary*.

In 1932 Sir Keith and his Directors decided to move the head office of the Company to London, and for a time the firm joined with Messrs. John Mowlem & Co., Ltd. The joint firm continued in existence until 1935, during which period it undertook a large number of contracts, including the Dover Train Ferry dock and a large amount of tunnelling in London. In 1935 the joint operations of the Company were suspended and Edmund Nuttall, Sons & Co. (London), Ltd., established their London Office at 22, Grosvenor Gardens, S.W.1. Sir Keith had for long been a firm advocate of moving the business to London and it was here that he finally established himself as the head of a firm, which, although of no mushroom growth, had certainly increased greatly in size and importance.

More and more contracts were undertaken, including many large

Admiralty works, the construction of the harbour at Port of Spain, Trinidad, and a section of the Trans-Iranian railway (in conjunction with *Hersent et Cie*).

During the Munich crisis in 1938, the firm undertook voluntarily to construct hundreds of Air-Raid Shelters in many parts of London and elsewhere. Those in London were mainly situated in Islington and Holborn. At a moment's notice the firm mobilized some 10,000 extra men, and many of the staff worked night and day with no sleep for a week or even longer. During this time Sir Keith was indefatigable, touring all the sites where work was in progress. He always toured around in a large car, in the back of which he piled anything and everything which he thought might be of help to the work and comfort of the men doing it. He would produce sou'westers and rubber boots at one moment, and coffee, sandwiches and chocolate at the next, so his visits, wherever they might be, were welcomed, not only on account of the encouragement and help he gave, but also on account of the practical "comforts for the troops" which he always so thoughtfully provided.

The crisis passed and the firm settled down once again to its more ordinary tasks. These were now nearly all connected with the defence of the country and the contracts undertaken were more and more for the Defence Departments or connected in some way with the war which was looming ahead.

At the outbreak of war the firm again started constructing Air-Raid Shelters, but these were of a more permanent nature, being mostly of reinforced concrete, although some of the old shelters constructed during the previous year were extended and improved. At this time most of the shelter work was in Finsbury, and once again Sir Keith took a lively interest in it. Those were the days when one was always expecting to hear the drone of enemy planes to herald the first raid of the war and one was working against time and always afraid of being a little too late.

On the very first day of the war, within half an hour of the Prime Minister's speech, Sir Keith declared his intention of joining the Army at once, but he wanted the firm to carry on as usual. Before the war he was always speculating on whether the war would materialize and was always asking people's opinion about it, but as soon as the die was cast he had no other thought than that his duty was to join up immediately. During the autumn of 1939 he did his best to get into the Army, but it was not until December that his chance came. At this time Major-General (then Brigadier) Appleyard was forming the Air Component of the B.E.F., and he asked for Civil Engineering firms to volunteer to recruit General Construction Companies for work on aerodromes in France. Sir Keith, at once, enthusiastically responded and the *Nuttall* General Construction Company, R.E., was recruited and mobilized.

The Company was formed on 23rd January, 1940, and proceeded overseas on February 11th. Sir Keith was its first O.C., and the officers were selected from the engineers employed by the firm. N.C.O's were selected from among the foremen and the men from the employees.

On arrival in France the Company was billeted in the village of Irles near Bapaume and were at once given the job of constructing an aerodrome at Grevillers. The organization of the work presented many novel difficulties, not the least of which was the supply of materials for the concrete runways and liaison with the French Railways, but the work that the Air Component did in France is another story, and will no doubt be told elsewhere. Sufficient it is for the moment to place on record that Sir Keith was appointed Officer in charge of all the Units on the Aerodrome.

When the German break-through came in May, the Company was evacuated to England and re-formed. On 5th December, 1940, Sir Keith was promoted to Lieutenant-Colonel on appointment to a C.R.E.'s command. The work on which he was engaged he found to be most congenial and once again he put everything he had into it. It was largely on account of his tremendous energy that his health broke down. Although time and time again he tried to carry on, he had to give in and then followed that tragic illness which eventually led to his death.

In the above outline of the late Sir E. Keith Nuttall's life, both in his business activities and during his period of service in the Corps, an attempt has been made to show the enthusiasm and keenness which he put into everything he did. He was a man of great personality and great charm. He was exceedingly generous and immensely popular with both his officers and his men. He was always on the look-out to see how he could help and never did he turn away anyone who went to him for help if it was at all possible for him to give it. He had a keen sense of humour and never lost a certain boyishness of outlook and a well-developed sense of the ridiculous.

He always looked upon his firm as a family business in the tradition of the nineteenth century rather than as a commercial Company, and many of his employees had been with the firm and known Sir Keith or his father for thirty, forty, or even fifty years. In the same way with the R.E. Company in which he took such pride, he always considered himself personally responsible for each officer and man under his command.

He loved horses and dogs and his favourite recreation was hunting. Both he and Lady Nuttall rode with the Quorn for many years. His country house was at Lowesby, Leicestershire, and he always took a very great personal interest in the problems of his estate. He was, too, very keen on racing, at which he had much success.

It will be long before those who knew him will forget him, and it is a tragedy, indeed, that his death should come at such an early age. With all those who knew him well he leaves a gap which it will be very hard to fill.

He was an Associate of the Institution of Civil Engineers and a Member of the *Société des Ingénieurs Civils de France*. In 1925 he married Gytha Primrose Harrison, eldest daughter of Sidney H. Burgess, who survives him, and they had one son, Nicholas Keith, who succeeds to the title. Sir Keith was mentioned in Despatches for the work he did whilst serving with the B.E.F. in France.

D.P.B.

All Reviews of Books on military subjects are included in the provisions of K.R. 547(c) *1940*.

BOOKS.

(Most of the books reviewed may be seen in the R.E. Corps Library at Brompton Barracks, Chatham.)

HISTORY OF THE GREAT WAR.

Military Operations, East Africa. Vol. I.

Compiled by Lieutenant-Colonel CHARLES HORDERN (late R.E. and G.S.), founded on a Draft by the late Major H. FITZM. STACKE, M.C., *p.s.c.*†, The Worcestershire Regiment.

(H.M. Stationery Office. Price £1 1s. od.)

This notice can be little more than an advertisement of the publication of this important addition to the *Official History of the War of* 1914–1918, as it was received too late for the preparation of a suitable review. So little has hitherto been published about the events which it details that it is certain to be welcomed by all who are interested in our dependencies in East Africa. The events described carry the war down to the end of September, 1916. To Royal Engineers there are many references of especial interest, *e.g.*, the Ruvu causeway, "a notable and enduring engineering feat," known as "Sheppard's Pass," in a footnote on page 364, the criticism of the use of technical units as fighting troops, on page 326, and the large amount of railway and road construction work carried out in almost all the districts affected.

A notable feature of the book is the generous, in fact lavish, provision of excellent maps and plans.

Editor *The R.E. Journal.*

THE LIFE OF GENERAL SIR CHARLES WARREN.

By WATKIN WILLIAMS.

(Basil Blackwood, Oxford. Price 25s.)

General Sir Charles Warren, G.C.M.G., K.C.B., F.R.S., Colonel Commandant, R.E., who died in 1927 at the age of 86, deserved a biography. He was truly an "eminent Victorian": during the last twenty years of the Nineteenth Century he was very much in the public eye, and achieved the honour of those days of a portrait in *Vanity Fair*, as well as a cartoon in *Punch*. He was employed on many curious jobs; held a variety of commands of both regulars and irregulars; stood for Parliament; was Chief Commissioner of the Metropolitan Police; and when General Sir Redvers Buller blundered in S. Africa in 1899, the public, both at home and in S. Africa, clamoured for him to be sent out, and he sailed in command of the 5th Division with a dormant commission in his pocket empowering him to succeed Buller if anything happened to that impossible commander.

Beyond what he did and always did well, notably the bloodless Stellaland campaign ("the real triumph of the expedition lay in the fact that its purpose was accomplished without bloodshed"), and the prevention of riots in London by anticipatory measures, Warren was a "character" and a very great personality. His biographer, his grandson, has happily and successfully brought this out; so that the book is not a mere gazette of Warren's activities, interesting as they are, but the living picture of a soldier and administrator, with an appropriate background of the times in which he lived.

The author says in one place "in this respect [not trying to please everybody] he strongly resembled General Gordon." But there was more than this. The two men had the same simple faith and trust in God; did their duty as they saw it, irrespective of persons; had the same gift of earning the devotion of irregulars; the same sympathy with the underdog; they both refused lucrative opportunities and were equally unable to suffer fools gladly, particularly if those fools were their temporary masters in the official hierarchy, and they spoke their minds and acted for the best, regardless of their future careers.

Warren's father, Major-General Sir Charles Warren, was an Indian and Crimean warrior; but his grandfather was Dean of Bangor, and his other immediate senior relations were mostly in the Church; when he was elected as F.R.S. in 1884 he had the honour of being the fifth F.R.S. in his family in four successive generations. The clerical and scientific strains certainly came out in "Charlie Warren," the name by which he was known in the Army. Educated at Wem Grammar School and for a short time at Cheltenham College, he entered Sandhurst in 1854. There in his first term he won a prize for Mathematics and, on account of his unusual ability for science and mathematics, was advised to try to enter the R.E. He successfully competed in the entrance examination for the R.M. Academy whilst still a cadet at the R.M.C., received leave of absence for the remainder of his year there, and in due course, in December, 1857, was gazetted to the Royal Engineers.

After only one year at the S.M.E., in January, 1859, Warren was "attached to an R.E. Company bound for Gibraltar," and there carried out a survey, made the well-known models of the rock and investigated its geology. In July, 1865, he returned to England to be appointed Assistant Instructor of Surveying at Chatham. At the beginning of 1867 he and three corporals R.E., were lent to the recently formed Society of the Palestine Exploration Fund, "to make discoveries in Jerusalem . . . by excavation or any other mode." Subsequently Sir Walter Besant (the novelist and antiquary), Secretary of the Fund, wrote that, in the teeth of Turkish apathy and hostility, "it was Warren who restored the ancient city to the world; it was he who stripped the rubbish from the rock and showed the glorious Temple standing within its walls . . . he who opened the secret passages, the ancient aqueducts," etc., etc. It was, however, in connection with the finding of the "Moabite Stone," which provoked an interest almost as great as the discovery in later years of the

tomb of Tutankhamen, that Warren's name reached public notice. He came home at the end of 1870 shaken in health, Lieutenant H. H. Kitchener being one of those who continued his survey of Palestine, and was sent as D.O. to Dover, in 1872, as engineer to the Shoeburyness School of Gunnery, and in 1875 to the Waltham Abbey gunpowder and small-arms factories. In the autumn of 1876 he was started on a new field of activity, in which he is still well remembered, being sent by the Colonial Office as H.M. Special Commissioner to survey and delimit the boundary between the Orange Free State and Griqualand West. He subsequently completed the land settlement and adjudicated on all the claims in connection therewith to everybody's satisfaction, having " an extraordinary knack of getting on with everybody he had to deal with, Boers, Griquas and natives alike." He received official thanks from both President Brand and the Colonial Office. His adventures he afterwards described in *The Veldt in the Seventies*."

Meeting Cecil Rhodes, then 24, in a coach, he had a long discussion with him about the XXXIX Articles. He refused an offer of £3,000 a year to take charge of the Kimberley diamond mines, now on the British side of the boundary, and was about, at the request of Sir Bartle Frere, to undertake the land settlement of the Transvaal, when Kaffir troubles (Transkei and Bechuana campaigns) arose. In consequence, in January, 1878, he was required for military duty and appointed Commandant of the Diamond Fields Horse, which worked in co-operation with the Frontier Light Horse under Major Redvers Buller, his later commander in Natal, with whom he became fast friends after an initial altercation. In the field, first in command of a column and then of the whole field force, Warren brought about a rapid victory, " as brilliant as it was unexpected."

Warren returned to Chatham as Chief Instructor in Survey in February, 1880, a post he held until November, 1884, less an absence of eight months in 1882, the year of Tel-el-Kebir and the occupation of Egypt, when he was engaged in the Sinai desert in the search for and capture of the murderers of the Palmer expedition (a party, including Captain Gill, R.E.), sent on an errand not unlike that of " T.E. Lawrence " in 1917. Except his official report, he wrote no account of this curious task, for self-advertisement was abhorrent to him.

In 1884 he had another strange duty. By his letter of instructions he was " to remove the filibusters from Bechuanaland," now a British Protectorate, whose territory had been jumped by Transvaal Boers " to pacificate [A.P.H., please note] the territory, to reinstate the natives in their lands . . . to prevent further depredations and finally to hold the country." All this he did, as already mentioned, without bloodshed and was promoted G.C.M.G., but was not given any Army promotion—however, Colonel (Sir Charles) Watson, R.E., got no reward whatever for the bloodless capture of Cairo and its citadel and forts in 1882.

Whilst on half-pay, after his return home in October, 1885, he stood for the Hallam Division of Sheffield as a Liberal, against the direct wishes of Lord Wolseley, the Commander-in-Chief, who warned him that if he did so he would never get another military appointment. He was defeated—and in January, 1886, was appointed Governor of the Red Sea Littoral. He made only a short stay at Suakim, as in March he was selected to be Chief Commissioner of Police for the Metropolis, in succession to another R.E. officer, Colonel Sir Edmund Henderson, who had held the post for 17 years, but had displeased the Government by his handling of serious rioting in and near Trafalgar Square on " Black Monday," 8th February, 1886. Warren had no easy reign: he had to deal with more attempts at rioting, the enforcement of the muzzling order, the 1887 Jubilee, the " Cass case " (the arrest of a street-walker), the " Jack the Ripper " murders. But, by due precautions and by the exhibition of adequate force, he prevented trouble and by using bloodhounds intimidated the Ripper. His ways, however, did not suit the gentle lawyer who was Home Secretary (his life is unwritten and his name forgotten), and Warren resigned. Then followed five years as the first G.O.C. at Singapore (where he had trouble with the Governor),

and the Thames District for three years, at the end of which, in the summer of 1898, aged 58, as a lieutenant-general, he again went on half-pay. From this rest he was summoned in November, 1899, to take the 5th Division to Natal.

Sir Redvers Buller ungenerously laid the blame on Warren for the abandonment of Spion Kop. The undisputed facts are that the officer in command on the hill who ordered the retirement was specially nominated for the post by the Commander-in-Chief and led his men down without reference to him or to Warren. The brigade-major on the hill strenuously opposed the order. Subsequent post-war conversations with Boers and Hollanders who were there elicited the information, as stated in the Official History, that they had earlier slipped off the hill and abandoned the contest. The account of the incident is well documented by the author.

South Africans outside and the garrison inside knew who relieved Ladysmith. Buller's statements in his despatch were shown to be erroneous, and he died—for other reasons—a discredited man. Beyond writing his own report to see that his officers and men got their due, and official letters to the War Office and to Lord Roberts, who soon after arrived, Warren took no action. Buller left Warren in command, in spite of his report on the Spion Kop incident, and after the relief of Ladysmith, Lord Roberts sent him to deal with a rebellion in his old haunts of Griqualand West. This done, in August, 1900, he was ordered home—Buller going about the same time—was promoted General in 1904 and placed on retired pay in August, 1905.

He took bad luck with the good and never murmured. He found numerous outlets for his still abundant energy, in particular with the Boy Scout Movement and the Order of St. John of Jerusalem. He wrote a full account of the Natal campaign, but made no attempt to publish it.

Three points in Warren's make-up are unmentioned. He took immense pains in teaching young officers at Chatham, and gave an unusual amount of time as a Chief Instructor in looking after them and getting to know them. He was a good linguist, at least knew many languages, and the reviewer can certify that his French was fluent, with a tremendous vocabulary. He was certainly at one time a teetotaller, as the reviewer has reason to remember. On a tour in the Isle of Wight, walking home with him, both got wet through. At the sight of a "pub" the reviewer suggested a drink, and got a lecture on temperance. At the second "pub," however, Warren stopped, entered without a word and ordered "two gins." The hopes of the reviewer rose; but Warren poured a glass into each boot, saying, "An infallible preventative of colds; we must hurry and catch the boat," and stalked out. One could add largely to the anecdotes about him in the book.

The photographs provided are excellent; the frontispiece showing Warren as G.O.C. Chatham in 1897 presents him exactly as we knew him.

J. E. Edmonds.

PRACTICAL MAP READING (AUSTRALIAN MILITARY HANDBOOKS).

By Professor J. Macdonald Holmes.

(Angus & Robertson, Ltd., 48 Bloomsbury Street, Price 5s. 6d.)

This little book is published under some handicap, as it covers much the same ground as the admirably written *Manual of Map Reading, Photo Reading and Field Sketching*. The arrangement is unusual—scales for example are only introduced toward the end of the book—and it starts off with a good deal of detail about the Australian Military mapping system, much of which the beginner is likely to find a good deal beyond him. The prismatic compass and the Service protractor are described and illustrated and there is a full-page plate of the Abney Level, but no word of explanation. Very little is written about the Plane table.

The author covers a great deal of ground in 140 pages, so that sketchiness is unavoidable, but it is to be doubted whether enough is written to make some parts

intelligible to a person who knows nothing of the subject, whereas it is too elementary for the more knowledgeable reader. A single page on the subject of projection with an unexplained diagram of the Transverse Mercator projection can mean nothing to the beginner nor will he understand much about resection from the terse description in the chapter on reconnaissance map-making. *It is surprising* to find in so short a book, two pages devoted to the old-fashioned arithmetical method of extracting square-roots!

The chapter on panorama sketching is good and so is that on aerial photography, an important subject for Australian readers. The final chapter deals with map-making for national administration purposes and the slope-variation map, representing slopes directly by bands of colour instead of indirectly by contours, is introduced. This method has its advantages in rugged country and more use might well be made of it in British practice.

D.P.

ARMY DISTRICT COURT-MARTIAL PROCEDURE.

By Major H. M. SHURLOCK, late R.E.

(Gale & Polden, Ltd., Aldershot. Price 7s. 6d.)

This work has been compiled with a view to assisting the Presidents and Members of Courts Martial and all Students of Military Law. I am confident it will prove of immense assistance to all who have the opportunity of reading it.

Here is the whole subject set forth in a concise and practical form.

As this work is not a substitute for the *Manual of Military Law*, I do think that it may be considered as an attempt to supply a vacant place. The Author has succeeded in that he has made the way easy for the Student who, I am sure, will feel he has made substantial progress after having perused its pages.

The ready way in which the many Forms and Charges are set out should prove of great value.

A great deal of time and thought must have been given to the preparation of it. To be concise and yet clear is admitted to be a very difficult task.

I am pleased to have been given the opportunity of writing this review.

H.R.H.

WELDING.

By A. C. DAVIES, B.SC., A.M.I.E.E., Member of Institute of Welding.

(Cambridge University Press. Price 10s. 6d.)

This book deals chiefly with oxy-acetylene and electric arc welding and with gas cutting, which are the processes principally used in the Corps. It is very clearly expressed in simple language, well set out and fully illustrated. It contains information useful to officers and mechanists and also goes into sufficient detail of elementary principles, the preparation necessary, technique employed and after treatment in the welding of the various metals for the beginner and for the man who wishes to improve his skill at his trade. By a recent amendment to Regulations, a Welder Class I or II now has to be proficient at both the oxy-acetylene and electric arc processes and unit commanders who have welders to train to a higher standard will find this book useful for the unit library.

The first two chapters of the book deal with elementary science and metallurgy as they apply to welding. They form a very good introduction to the subject, since they explain in simple language such things as the compositions and properties of metals and alloys, and the effect of heat on them. Heat is dealt with both regarding its effect on their mechanical properties and also from the point of view of expansion

and contraction, which may cause distortion which must be guarded against. The action of oxygen and nitrogen on metals and the composition and use of fluxes are also explained.

The next chapter is concerned with the practice of oxy-acetylene welding. After describing the various types of apparatus and methods of use, the author goes on to give details of the welding of mild steel, cast iron, non-ferrous metals and special steels such as stainless and nickel-clad steel. He also gives the processes for depositing a hard surface and for welding with bronze. For each metal or alloy, the proportion necessary, the type of flame and filler rod, the technique of welding and any after treatment necessary, are gone into in sufficient detail for an operator to carry out the weld. The necessity for pre-heating the job in certain cases and some of the methods employed are also described.

Electric arc welding is dealt with next. The chapter on this subject starts with a very clear and simple description of electric principles as applied to welding, followed by details of types of generators and transformers used in D.C. and A.C. welding. Next comes a description of various types of electrodes, the principles on which they work and the methods and difficulties met with in using them on various joints and when welding in various positions. Illustrations are given showing various faults in welding and how they are corrected. All this leads up to the methods employed in welding various metals and alloys. As with the chapter on oxy-acetylene welding, the preparation, technique and after treatment where necessary are given in sufficient detail for the operator to carry out the work. The use of the carbon arc for welding and cutting is also dealt with in this chapter.

The fifth chapter is on the gas cutting of iron and steel. The effect of the process on the metal is discussed and some hints given that will assist in special jobs. After this follow details of the inspection and testing of welds. Although some of the tests described require a laboratory, many of them can be carried out in the field or in a workshop, and besides being of use in inspection of actual jobs, will help in teaching and in the trade testing of welders. A brief survey of other welding processes is then given. These include automatic arc welding, the atomic hydrogen process and resistance and thermit welding. While these processes are not practicable for use in the field, they are of interest to officers and mechanists as processes in the manufacture of stores and plant which they may be required to order or to use.

The final chapter deals with the principles of engineer drawing, a knowledge of which subject is necessary to Class I welders. The appendix at the end of the book contains a variety of subjects such as costing, earthing of electric welding plant; useful tables, such as composition of alloys, gauges, and conversion tables; also practical tests and questions for students in the oxy-acetylene and electric arc processes. The answers to all the questions can be found from a study of the book, which covers most of the subject-matter, theoretical and practical, required for the City and Guilds examination in Electric Arc and Oxy-acetylene Welding and Welding Science. These tests and questions are commended to the notice of Officers who have to set trade tests to welders.

The book can be recommended to those wishing up-to-date information on welding and is worth its place in a School or Unit technical library.

C.W.

BLITZKRIEG.

By F. O. Miksche, Major, General Staff Spanish Republican Army. (Faber and Faber, Ltd., 24, Russell Square, W.C.1. Price 12s. 6d. net.)

This book contains a very interesting and detailed account of the German method of carrying out a *blitzkrieg*. This form of war is founded on the British attack at Cambrai in the autumn of 1917, but to obtain a decisive success with it, tanks have

to be used in large numbers, and supported by motorized infantry and the air arm.

The Germans with their usual thoroughness, and with the experience of the Spanish War to guide them, worked out a system of an attack in three following echelons of tanks and motorized infantry, supported by dive-bombers, with a fourth echelon of "combat teams" to make good the ground gained by the tanks, and to widen the breach. The "combat teams" consist of infantry units equipped with a variety of weapons to make them self-supporting, and to enable them to deal with hostile tanks.

Ordinary Infantry Divisions then advanced, and relieved the combat teams. The actual attacks were normally concentrated at two or three places on a twelve-mile front, and the attacks relied for their effect on their speed and depth of penetration.

So far by this method the Germans have made remarkable progress, due no doubt to the initial overwhelming preponderance of men and material at the decisive point, as well as to the novelty of the tactics.

There is however an antidote to it in the form of heavily defended localities or "islands of resistance" dispersed in great depth, which by holding back the hostile infantry and interfering with the supply of the enemy's forward tanks and motorized units, gain time for the defence to organize a counter-attack.

This system appears to have been adopted in Russia, where for the first time in this war the Germans have had to engage forces on more or less equal terms as regards numbers, arms, equipment and air strength.

The *blitzkrieg* on the major scale seems to have failed, and the Germans are now attacking with small forces of tanks, supported by infantry. They are in fact reduced to a slogging-match against the defended localities, with the Russian artillery, grenades and mines taking heavy toll of their tanks.

It would seem that in the future a major *blitzkrieg* on a large scale against an enemy equally well equipped with mobile forces, protected by adequate defence measures and endowed with a fighting spirit, is bound to fail, though local tank successes will always be obtainable. Under the above conditions, the campaign will as usual degenerate into a test of human endurance, and will be decided by morale.

Major Miksche advocates many alterations in the pre-war organization of armies, and his book is worthy of close study, and especially by those who anticipate having to meet a *panzer* thrust.

C.G.F.

MAGAZINES.

THE MILITARY ENGINEER.

(*July–August*, 1941.)—*The National Defence*. By The Hon. Frank Knox.

A report of an address delivered before the annual meeting dinner of The Society of American Military Engineers.

In his speech Colonel Knox traces the gradual change that has taken place in American policy since the beginning of the war: first, the amendment of the neutrality laws, next the Lend-Lease Act, and, finally, the whole-hearted support of Britain in the Battle of the Atlantic.

Military Engineers To-day. By Major-General J. L. Schley.

The expansion of the Corps of Engineers during recent years has been remarkable. Two years ago it consisted of 800 officers and 5,500 men; at the time the article was written its strength was 3,400 officers and 50,000 men, to be increased in four months' time to 4,200 officers and 61,000 men. There is a large reserve of 8,000

Engineer Reserve officers available for calling up: 3,000 of these will have been called to active service by the time the present army objective of 1,400,000 men has been reached.

The mechanization of Engineer units has been one of the greatest changes that has taken place in recent times. The World War Engineer regiment had a strength of 2,000 officers and men; it marched on foot and worked largely by hand. The present divisional Engineer battalion has a strength of 634 officers and men: it is completely motorized and works largely with power tools. The American Army is the only one that uses that invaluable item, the dump truck.

There is always an Engineer Section in the Staff of Divisions and higher units. In the case of the Division, the Engineer Staff Officer also commands the Engineer units. In Corps and higher units, the Engineer Staff Officer is charged with his technical staff duties only.

Military Obstacle Course.

A sketch plan and a series of photographs illustrate the Military Obstacle Course which forms part of the training at the Engineer Replacement Training Centre at Fort Belvoir.

Inspection of the Washington National Airport. By H. L. Cheney.

The construction of the Washington National Airport was begun in the autumn of 1938. The master plan provides for the extension of the present flying field up and down the Potomac River, which will make possible the future construction of parallel runways and permit the North-South runway to be extended to an ultimate length of 8,000 feet.

The total area of the site covers 729 acres. Nearly half of it consists of tidal flats reclaimed with dredged material.

The hangars are spacious and up-to-date. The largest hangar has a door width of 223 feet with a clear height of 45 feet, and can accommodate the largest of the Army's latest planes. (The B 19 has a wing spread of 212 feet.)

Air Raids and Protective Construction. By S. B. Smith.

A description of the various types of bombs likely to be used in air raids, based on European experience, with details of their trajectory and destructive effects. A pilot, travelling at 210 miles per hour, at an altitude of 20,000 feet, must maintain a steady course from a distance of 5 miles from the target, and must release his bombs when 2 miles short of it.

Some photographs are given showing air-raid damage caused in London. There are also plans and sections of shelters for large and small groups respectively.

Pre-fabricated Wood Hangars. By T. D. Peters.

In order to meet the requirements of the expanded Royal Canadian Air Force and of British cadets training in Canada, the Construction Division of the R.C.A.F. undertook the construction of pre-fabricated wood hangars in large quantities. It was found that the cost of a wooden hangar was from 15 to 20 per cent. less than that of an all-metal hangar. One mill in British Columbia was able to turn out two or three hangars per day.

It was also found that wooden hangars were often more safe from fire than those built of so-called fire-proof materials, which will not themselves burn, but will fail under high temperatures. At 1,100° F. certain structural metals lose more than half their normal tensile strength, and at 1,700° F. they will not support the weight of a structure. When wood trusses burn they lose strength only in proportion to the degree of charring.

Air Ports in National Defence. By B. E. Gray.

To ensure protection against a possible air attack, the United States require not only a large force of fighter planes, but a large number of air ports—thousands of them. At the present time there are about 20,000 planes in use in the United States, and over 2,500 air ports of varying size and efficiency.

It is now proposed to build 50,000 aeroplanes annually. In order to accommodate these, a vast number of air ports will have to be built all over the country, if overcrowding is to be avoided.

Questions to be considered in connection with air ports are the direction and length of runways, the loads the latter will have to carry, and their thickness. The runways may be rigid or flexible. Arrangements for their proper maintenance are essential.

Bolivia and the Arica-Santos Railway. By Captain LeRoy Bartlett.

A description of Bolivia: its history, physical features, climate, etc. Bolivia, having lost much of its original territory in a series of boundary disputes, and having no longer any seaboard, depends upon railways for its foreign trade.

It has been decided to push on with the construction of the uncompleted portion of the transcontinental Arica-Santos railway. This portion lies between Vila Vila (8,200 feet above sea level) and Santa Cruz (1,400 feet), and is about 350 miles long, all within Bolivian territory. The railway will have strategic as well as commercial value.

Rapid Road Cratering.

As a result of the investigation and study carried on since November, 1940, the single-charge method of cratering has been declared obsolete, and the multiple-charge method has been adopted as standard.

The following are some of the conclusions arrived at:—

(1) Effective tank obstacles may be created by the multiple-charge method.

(2) Good results can be obtained by making bore-holes alternately 5 and 7 feet deep, and placing in them charges of 50 lb. and 75 lb. respectively.

(3) Any commercial high explosive can be used.

(4) About 150 feet of cheap annunciator wire should be used as connecting wire between the lead wires and the charge, to avoid damaging of the lead wires by flying concrete.

(5) The cable should be led off from the line of blast holes at an angle of 45° and kept to windward of the charge.

(6) Mud capping is more effective than using a drill-hole in breaching the concrete. (With this method charges of 4 lb. of dynamite are used—on each charge is placed a mud-cap 12 inches high and 16 inches in diameter.)

The Upper Mississippi River Project. By Colonel C. P. Gross and H. G. McCormick.

A description of a project for improving the Upper Mississippi between St. Paul and St. Louis by providing a navigable channel 9 feet deep. A series of dams and locks will be constructed. The upper reaches of the Mississippi are not liable to the heavy flooding that occurs periodically further downstream and in the Ohio River.

The scheme, which is now approaching completion, will provide a navigable channel connecting the Great Lakes with the Gulf of Mexico at New Orleans, and will be of considerable commercial, as well as strategic, importance.

Military Bridges and Bridging. By Captain C. E. Mullins.

One of the German armies taking part in the drive on the Western Front in the summer of 1940 built 57 pontoon bridges and 183 emergency bridges, 75 to 1,200 feet long, in a period of 8 to 10 weeks. Each bridge had a capacity of 16 to 24 tons. The importance of these figures is staggering. Bridges of this size cannot be improvised if the speed of a *Blitzkrieg* is to be maintained.

The American Army possesses three types of floating bridge equipment: (1) foot bridge; (2) 10-ton pontoon bridge; (3) 25-ton pontoon bridge. The equipment is good and fairly well suited to present needs, but many officers consider that a light bridge is needed for close support of the infantry. The bridge may be built with half-boats and treads, or with rubber pontoons with treads, or with rubber pontoons, utilizing standard baulks and chesses. In the writer's opinion, a wheel-tread bridge is as satisfactory as a fully decked bridge. The writer favours a bridge constructed from half-boats and light trusses. Chesses may be laid later, after assembly.

Of the two types of bridges, fixed and floating, the ratio of 57 pontoon to 183 fixed bridges may be taken as a suitable average. The greatest need at present is for well-designed fixed bridges of the portable-trestle or fixed-span type. There are now two standard pre-fabricated steel bridges—light and heavy. The light bridge will carry a light tank over a 72-ft. clear span; the heavy bridge will carry a medium tank over a 125-ft. span. Three bridges of larger capacity are under development.

The writer stresses the importance of giving Engineers constant practice in bridge construction.

Rubber in the National Defence. By F. L. Haushalter.

In order to maintain the high speeds necessitated in modern warfare, army vehicles must be equipped with either pneumatic or special cushion tyres, or with rubber tracks, or with a combination of tyres and tracks. Tyres must be made reasonably bullet-resisting. Fuel tanks must be sealed against the penetration of bullets: this is accomplished by an outside coat of rubber of special construction.

Rubber enters largely into the construction of gas masks and aeroplanes. De-icers on the wings are pulsating rubber attachments. There are numerous other uses for rubber such as hose-pipes, rubber boots, pneumatic boats and rubber-treated fabrics, all of which play an important part in national defence.

Russia in the World War, 1914-18. By A. M. Uzefovich.

An account of the part taken by Russia in the World War. In the war against Russia the Central Powers utilized on an average, 60% of their available forces, as against 40% against the Western Front in France.

The record of the Russian Army in the World War is much more glorious than is commonly believed. The Russians captured more prisoners of war (2,200,000) than all the Allies together and a larger number of artillery pieces (3,850) than any other army. By attracting the German offensive to themselves, the Russians suffered the greatest losses of any combatant. Out of 15,500,000 men mobilized, 2,100,000 were killed or died. The total losses of the Allies amounted to 10,000,000.

Marshal Foch admitted, after the war, that France owed it to Russia that she was not wiped off the map of Europe.

Engineer Troop Activities; Recent Field Improvisations.

Lieut. W. G. Trainer describes a few improvised works :—

(1) A suspension bridge, consisting of a steel cable, laid double, stretched across a gap, secured to trees on both banks, and strained by means of a 1½-ton winch truck, carrying a roadway of 2-inch planks;
(2) A foot-bridge made of wooden planks and lashings;
(3) A corduroy road across a swamp;
(4) A semi-permanent bridge across a river, built mainly of salvaged timber.

A.S.H.

REVUE MILITAIRE SUISSE.

(*May*, 1941.)—*Réflexions sur la Campagne de France* (continued). By Capt. E. Bauer. A further instalment of some trenchant criticisms on the discordance between French policy and French national defence, which led to the collapse of France in June, 1940. This stupendous event will certainly invoke much examination as to its causes. On several previous occasions France—and not only France—has failed to grasp the significance of military changes, and the swing of military power. Between the Crimean War and 1870 she failed to take heed of the warnings of Marshal Niel, or of the rapid defeat of Austria. After 1918, she threw over the warnings of Foch; and her politicians indulged in a scramble for office, thinking themselves safe behind their Maginot Line.

The author's present instalment refers principally to the failure of doctrine and of material production. He points out that on the eve of the war, France had actually

a great superiority over Germany in motor vehicles of all kinds. This also meant a superiority of drivers, who could have driven the tanks and lorries if the Army had provided them. But the French infantry were still to tramp the *pavé* roads with their 1914 loads on their backs.

It was not for lack of exposition of the lessons of 1914-18 that the French Army was ill-prepared. The efforts of a dozen skilled soldier-writers had issued from the French press, which has always produced a line of military studies of great interest and value. It still remains true that the study of the last war is the best basis for the study of the next one. It did not require the training and experience of an Intelligence Staff to see the trend of German military development as soon as Hitler came into power.

Turning from generalities, the author calls attention to two initial errors which strike even the uninitiated. The French doctrine at the outbreak of the war was that the maximum frontage which could be allotted to an infantry division ought not to exceed 2½ kilometres in attack, or 6 to 7 kilometres in defence. The number of divisions required must include reserves and allow for losses. Actually, on June 5th, Weygand had only 43 divisions left for the 260 kilometres of front between Longuyon and the Channel, which, allowing for reserves, gave an average frontage of 12 kilometres per division.

The second observation is that an absolute obstacle in a military sense is a relative matter. General Corap's Ninth Army had only 5 divisions, two of which were Reserve divisions, to hold the Meuse between Meziéres and Namur, a distance of 90 kilometres. The reliance placed on the river as an absolute obstacle took no account of the possibilities of air attack interfering with demolition schemes.

General de Gaulle had done his best to push the increase of armoured divisions, and had gained some support in the Chamber, but Daladier turned him down, and the deputies went on with their smug reliance on the fortified obstacle.

Commentaires sur la guerre actuelle. In Cyrenaica, the halting of the German invasion at the Egyptian frontier, and the holding of Tobruk as a thorn in the side, are noted. It was considered at the time of writing that Tobruk would be heavily bombed and that it might find itself in sore straits; on the other hand, if the British succeeded in reinforcing the garrison by sea, the situation might change. It is remarked that the British Navy, although part of it was busily engaged in escorting troops to Greece, did not collaborate in stemming the German attack from Tripoli, probably because of the "immense superiority of the Italo-German air forces"! The hammering which these forces received at the hands of the R.A.F. may perhaps be remarked in the next month's commentary.

In Abyssinia, the Italian stubbornness in resistance is noted, but not the swiftness of the British columns.

Ali Raschid's abortive rising in Irak is interpreted as an attempt to rid Irak of British influence, with or without German help.

(*June*, 1941.)—*Le Pétrole et la Guerre.* By R.

A timely article on the mainspring of modern war.

The rapid development of the internal combustion engine, and with it, the prodigious expansion of aviation, have overshadowed the economic history of petroleum. In this short article, the author takes us back to the days when the Greeks made use of oil and sulphur to confound their enemies. To-day, the influence of petroleum is unbounded. The war could not be waged without it. It could not have been begun. Not a brick of our battered cities would have been out of place. How then have we and our American friends acted in the past to ensure our share of control in its development?

The writer gives us a sketch of the struggles of the giants of the business to gain mastery. Among them are Deterding, Rockfeller, Samuel, Gulbekian, Basil Zaharoff, Rothschild, and Stalin. None of them British names, yet Britain is represented in all their organizations.

Details are given of the production of the various oilfields; and fortunately for us, the American fields produce by far the largest amount. The total annual production is in the neighbourhood of 300 million tons. We may be thankful for the strategic situation of the bulk of the world's oilfields. We have to safeguard the greatest possible number of oil sources, and to obtain control over all which are vital to our success. The Caucasian oilfields, and behind them the oilfields of Persia and Irak, are steadily coming into the foreground of our struggle.

Réflexions sur la Campagne de France. By Capt. Bauer.

This third instalment opens with the remark that more than eight months elapsed between the German attack on Poland and the invasion of the Netherlands. "This unexpected delay gave General Gamelin's army a last chance to prepare itself for modern war, but this last chance was not seized."

All the new methods of fighting: dive-bombing, close collaboration between armoured cars and *Luftwaffe*, between tanks and pioneers, break-through strategy, envelopment, and exploitation to the furthest limit—were brought into play against the Polish armies. The lessons were lost upon France. Neither the French nor the British had anything to correspond to the *Stukas*.

Marshal Smigly-Rydz was blamed by the French for having disposed his armies in a long cordon, parallel to the frontier, without consistency or depth. The French disposition on the 10th May, 1940, showed almost the same faults. Where the French expected no probability of a break-through was precisely where the break-through was effected.

Then there were huge deficiencies in the equipment of the French Army. Troops sent to Norway had no mountain equipment; when they returned, they found great heaps of such gear stored at Bordeaux. Barbed wire was scarce in the Eighth Army; yet piles of it were found at Giromagny. The failings of the French Army of 1940 bear a strong resemblance to those of 1870. Musketry training was very meagre; many of the troops had not fired a rifle when the war started. Five Frenchmen fell for one German. Not only were the French soldiers armed to an inferior degree; they lacked confidence in their arms.

Commentaires sur la geurre actuelle. The Battle of Crete is the subject of this month's commentary, "one of the most interesting military operations of this war." The British enjoyed on the sea a superiority as incontestable as that of the Axis in the air. The triumph of the air power, however, provides definite proof, says the writer, that a fleet, operating without air assistance, can no longer claim the mastery of the sea. "From the day when the English communiqué announced that the British Air "Force had been withdrawn from the Island, the latter's fate was sealed."

In Norway, Holland and Greece, the German paratroops had limited their action chiefly to the capture of aerodromes. In Crete, they fought practically the whole battle.

The Germans had every advantage except sea superiority. They had the aerodromes of Greece, from which they could maintain a continuous aerial bombardment of Crete. They had occupied the numerous islands of the Ægean, affording them still more bases. Finally, they had overwhelming superiority of numbers. After two weeks of bombardment, the first wave of assault consisted of parachutists and infantry carried by areoplanes or gliders towed by aeroplanes.

This feature of an assault by air—the action of parachutists sufficiently armed and sufficiently numerous to hold their ground until stronger bodies arrive—is the most important lesson. If the first landed parties can be swiftly overcome, time has been gained to deal still more effectively with the next comers.

The use of gliders is also noteworthy. These require much less clear ground for landing. But they are extremely vulnerable while being towed in the air. It was the absence of the fighter squadrons which enabled the Germans to land so many of their airborne troops.

W.H.K.

ARMY EDUCATION.

Since education in the Army, always an important part of a soldier's training, has become a matter of national importance, the re-appearance of *Army Education*, the Journal of the Army Educational Corps, after an absence of some two years, is specially opportune.

The introductory foreword, by Lieut.-General Sir Ronald F. Adam, K.C.B., D.S.O., O.B.E., puts the situation very clearly; in it he gives the core of the problem, viz.:— "the 80 per cent. of the men in the Army who are not at present interested in education, and who must be persuaded of its advantages and brought into the experiment."

His masterly foreword, there are less than 170 words in it, could not be bettered.

He continues with this great truth, "Faith in the cause of education and knowledge are required to move the obstacles in the path of progress," and concludes with these words, "I therefore welcome the resurrection of the Journal of the Army Educational Corps, which can spread that faith and enlarge the knowledge amongst those engaged in the vital task."

There then is plainly given the purpose of *Army Education*.

It may be argued that *Army Education* is meant for members of the A.E.C., but, as pointed out by Mr. Bendall, Director of Army Education, in the first article, one of the special difficulties with which those responsible for the solution of the problem are faced is that "there is not complete conviction among Commanding Officers that there is time or need for education."

This feeling among Regimental Officers is due largely to ignorance of the kind of service the A.E.C. is able to give; many imagining that all that is offered is a number of classes such as they endured at school, but with a Master in uniform instead of in Cap and Gown.

Anyone reading the articles will quickly see that not only is this idea quite wrong now, but that a great deal of thought is being given to practical and improved methods of teaching, so that it is not just a matter of book learning which is offered but one of mind training. Even those who lay no claim to Scholarship will realize that there are many ways in which they can take an active part in the proceedings and, besides enjoying it, in doing so they will learn a lot about their men which they would not do in any other way.

The first article is written, appropriately, by The Director of Army Education, F. W. Bendall, Esq., C.M.G., and bears the title "The Aims of a War-time Academy" (to the reader it should be made clear that it does not refer to a re-formed and possibly reformed "Shop," but to an Academy in its wider meaning, or as one dictionary puts it "A society of men united for the promotion of arts or sciences in general").

In other words, the *Journal* opens with an explanation, on the best authority, of the aims of the present scheme for Army education. He gives these as "broadly speaking, (1) To keep men's minds interested and alert. (2) To do something for the future, especially of the younger men."

Mr. Bendall then analyses the problem by considering the difficulties of persuading men, who, as civilians, except in the case of a very small percentage, took any part in organized education, to be interested and helped, and points out the special difficulties of Army life in war-time.

He then gives the broad outline of how the few who are interested and the many who are not are to be catered for.

After a general discussion of possible and desirable aims, he concludes by summarizing their objective, viz.: "to stimulate the many and give opportunities to the few."

"Education in a Training Unit," by an anonymous Unit Education Officer, is a most heartening article, and gives much sound and practical advice on how Education,

or indeed any activity, should be tackled; the details of what he has done and hopes to do will be of great value to anyone who has to deal with the problem.

The author, like Mr. Bendall, stresses the importance of the Commanding Officer's support, and suggests various other methods of helping to further the men's education. But he modestly omits to mention how important it is to have an enthusiast, with sound and practical ideas, to handle the job; only his own C.O's can speak with authority, but the article gives the impression that even if a C.O. was not "bitten with the idea" at the outset, he would soon be converted into an enthusiastic supporter.

Other articles include "Education in the Canadian Army," by Dr. A. E. Chatwin and "A civilian lecturer looks round," by H. W. Howes, M.A., M.SC., PH.D., the latter, if, as seems probable, his talks are in the same happy vein as his article, suggests one way of popularizing Education, if a Unit is lucky enough to secure his services.

"On the other side of the hill," the translation of a German broadcast, with which the *Journal* ends, gives the German method of solving the problem of Education, though they call it "Cultural care of the Troops." A distinguished foreigner once criticised the British for always thinking that their friends were right and their enemies invariably wrong; the latter, at least, is a grave mistake, where Germans are concerned, in military matters.

The whole broadcast merits careful consideration, and much of it—for example, that war aims must be made clear to the men, and the provision of wireless sets, film projectors and musical instruments, where these things are not being done in our own army—could be copied with advantage.

A.R.A.I.

THE INDIAN FORESTER.

(*June*, 1941.)—*The Influence of Forests on Climate* is treated of by Mr. Warren. It is now generally admitted that forests do influence the local climate to some extent, producing a heavier rainfall than would otherwise be the case. Unsolved questions are, however, to what extent the modification of climate spreads beyond the forest boundary, and secondly, whether the greater humidity is attained at the expense of greater aridity in neighbouring tracts. It is suggested that these be made the subject of careful research. Existing theories are based on an insufficiency of data.

The Director, Indian Forest Ranger College, Dehra Dun, gratefully acknowledges the help given by the Commandant and the Superintendent of Instruction, K.G.V.'s.O. Bengal Sappers and Miners, for a valuable course of practical engineering for rangers under training.

Food and Wood (an extract from the *Scotsman*), is the title given to the presidential address to the Edinburgh University Forestry Society by Sir J. Sutherland. With every major war, come Government orders to landowners to fell forests and bring more land under cultivation. It is time, he says, that the services were correlated, and plans for war measures prepared in peace.

(*July.*)—*Loranthus* is a parasite on many Indian trees, and a very deadly one. Fortunately, it is easily recognized by its long greenish-yellow viscid leaves. The only known remedy is the lopping and burning of all affected boughs. A layman may be excused for wondering whether two plates in the magazine, depicting before and after treatment, have not had their titles exchanged.

The record speed for the flight of birds is said to be that of the Californian duck-hawk, namely 170 miles per hour. The fastest non-American bird is the Golden Eagle of the Western Highlands, which has been timed to do 120 miles per hour.

F.C.M.

CORRESPONDENCE.

LAYING AND FIRING CHARGES.

To the Editor, *The Royal Engineers Journal.*

SIR,

The late Major J. S. Becher's article in the September issue of *The R.E. Journal* on the method "laying and firing charges which may have to remain in position for a long period," is of considerable interest, but it contains some statements which experience shows to be incorrect.

The first mis-statement is that, where the charge cannot be left in a factory-sealed container, an explosive "such as Gelignite which, though wet, will remain serviceable for many weeks," should be used. In actual fact, Gelignite is a most unsuitable explosive to use in a wet situation. The Nitrate of Soda is liable to dissolve out of the Nitro-glycerine, carrying with it a certain amount of N.G., the resulting solution, depending on the proportion of the N.G., being highly dangerous. The explosive left behind becomes rapidly more and more insensitive and loses most of its explosive power until finally it will not explode at all. The only N.G. explosives which are not affected by water are Blasting Gelatine, which is highly sensitive to rifle fire, and explosive 808, both of which have a safe "life" of up to one year under water, provided they are initiated by a primer.

The article also states that a dry gun cotton or C.E. primer should not be used, the primers being Gelignite or Blasting Gelatine. It is essential that the primer for a main charge should be one detonating at very high velocity, as otherwise the main charge will not detonate at its maximum velocity, or even at all.

The velocity of detonation of the N.G. explosives varies greatly according to the power of the initiating impulse, and to obtain maximum velocity, it is essential that either a gun cotton or a C.E. primer should be used in addition to the detonator. Provided a water-proof explosive is used as the main primer, the dry primer can be inserted into it and water-proofed with the explosive itself.

The tube containing the primer and leads, which is the main feature of the idea, is described as being of zinc or similar light tube. It is most important that copper tube should not be used for this if there is any likelihood of it coming into contact with Ammonal.

I am, Sir, etc.,

F. E. FOWLE, *Brigadier.*