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THE ROYAL ENGINEERS JOURNAL.

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MONTGOMERIE PRIZE.

ATTENTION is invited to the conditions under which this prize, in value about £10, is offered for competition each year.

1. The Prize shall be awarded by the R.E. Institute Council in the manner considered best for the encouragement of contributions on professional subjects, by R.E. Officers, to the Corps publications. From the beginning of 1920 it has been decided that the Prize shall be confined to Officers on the Active List not above the rank of Substantive Major.

2. The Prize shall consist of (*a*) a book on Survey, Exploration, Travel, Geography, Topography, or Astronomy; the book to be whole-bound in leather, and to have the Montgomerie book-plate with inscription inside; (*b*) the remainder of the year's income of the Fund in cash.

3. The name of the recipient of the Prize shall be notified in the Corps publications; and copies of the contribution for which the Prize was awarded shall be presented to the representatives of the donors.

The following are suggested as subjects for contributions:—

(*a*). Descriptions of works actually carried out in peace or war.
(*b*). Inventions.
(*c*). Design (excluding works of defence).
(*d*). Labour organization on work.
(*e*). Scientific investigations generally.
(*f*). Accounts of exploration work and surveys.

THE EFFECT OF TANKS ON PERMANENT FORTIFICATION.

By Bt. Major M. F. Grove White, D.S.O., O.B.E., R.E.

It is realized that in the following notes opinions are expressed which are controversial. It is not desired to insist on the correctness of these views. It is desired, however, to open up discussion on a subject to which insufficient attention has been paid, viz., the effect of tanks on the future development of fortification.

A good many articles have appeared from time to time in the *R.E. Journal* dealing with the future of Permanent Fortification. The general trend of these articles is that this type of work will merge into Field Fortification, but that development of communications and measures for Anti-Aircraft defence will be the chief factors in the organization of a frontier for war.

In this article it is desired to examine the probable effect of tanks on permanent fortification at the commencement of a war. To do this it is necessary to examine the conditions which are likely to exist. By permanent fortification is implied work of such magnitude or scope that it will usually be carried out in peace time as a preparation for war.

When war is declared between two nations, such as France and Germany, the Frontier Corps, which in peace time are much more nearly on a war footing than the corps in the interior, at once deploy, facing each other on the frontier. The rôle assigned to these corps is to gain time for the assembly, concentration, and subsequent deployment of the main armies behind them. Hitherto, they have been supported by the great frontier fortresses, e.g., Verdun, Toul, Epinal, Belfort. These fortresses form pivots for the defence and so facilitate the gaining of time by the Frontier Corps in case of attack. Speaking generally, the rôle of these corps on both sides will be defensive.

Unless one side adopts a purely passive defence,—a hopeless proceeding,—each side will endeavour to gain the initiative by attacking first. The side which can mobilize and concentrate first will usually be in a position to seize the initiative.

Mobilization will probably be worked up in peace time to the highest pitch of perfection and, therefore, once war is declared, an

army should first prevent interference with its own mobilization and then, if it can, hinder the enemy's. But between it and the enemy's mobilization areas lie the enemy's Frontier Corps, and, by virtue of the great defensive power conferred on troops by modern fire-arms, these corps up to the present have been usually strong enough to stave off any attacks which can be made with the troops available before mobilization is complete.

As soon as one side is ready it will attack. The other side will endeavour to delay the hostile advance and so gain time to effect a redistribution of troops with which to stop the attack and subsequently, by launching a counter-offensive or otherwise, to regain the initiative. If this time cannot be gained defeat will probably result, always assuming of course that the attacker's plan is good and that he makes no mistakes. Therefore the object of the attacker is to sweep away the initial opposition quickly, the defender's to gain time. Here again the defender will rely on the defensive power of modern fire-arms.

It follows then, that in a war on a continental scale all armies will almost certainly at some time or other be forced to interpose a barrier between their main forces and the enemy, so that they may gain time to allow their plans to take effect. This barrier has been the fire power of relatively small bodies of troops and these troops have used fortification to increase their defensive power. Up to the present General Langlois, quoted by a writer in the *R.E. Journal* recently, was justified in saying that the strength of resistance lies in invisibility and in the extension of numerous and relatively feeble obstacles.

But lately there has appeared an instrument of war, the tank, to which numerous and relatively feeble obstacles are no obstacles at all, and which can pass unharmed through belts of fire which would be impassable to infantry. The chief feature of this weapon is its offensive power and the enormous assistance which it gives to an attacker in sweeping away opposition.

We may expect the tank of the future to possess the following qualities :—

(*a*) Power of manœuvring at night and in smoke or gas clouds.
(*b*) Great speed, 30 miles an hour or more.
(*c*) At least as great power of crossing obstacles as at present.
(*d*) Power of striking at a point at least 150 miles from its base and returning.
(*e*) Power of floating and crossing rivers or water self-propelled.
(*f*) Power of climbing slopes of 1/1 at least.

The power of artillery to deal with such tanks will be very much limited by (*a*) and (*b*) above. This also applies to aircraft, anti-tank rifles, anti-tank machine guns, rifle grenades, and similar weapons.

The effect of (*c*), (*e*) and (*f*) will be that practically no natural obstacles will stop a tank except large marshes, thick woods and precipitous mountain ranges ; (*b*) and (*d*) will give the tank the power of striking at vital points behind the enemy's lines.

It is obvious that troops deployed behind numerous and feeble obstacles cannot hope to deal with fleets of tanks of this nature and, in consequence, each army will try to make tank raids through the opposing lines with the object of delaying the hostile mobilization and concentration.

Fleets of tanks also will come into action with the main attack and, by sweeping away opposition quickly, will prevent the enemy from taking counter-measures in time. In fact, the obstacle of fire-power, as we understand it at present, will cease to exist, and it will be necessary to find some other obstacles capable of holding up tanks.

A water obstacle will be of little value ; tanks will be able to bridge it or float across it very easily. A vertical wall or better still a broad ditch with vertical sides would stop a tank or at any rate delay it considerably. Of course, it would be possible to detroy such an obstacle by mining or bombardment, but such a measure would entail delay and enable the defenders to concentrate guns and tanks at the threatened point.

Afforestation of a frontier might be of value.

Mine fields may be used. These mines might be electrically controlled. Even contact mines might be used successfully. Any attempt to clear a passage by pushing a roller in front of a tank is not likely to be successful, as a fuze can easily be designed which will act only under sustained pressure. If anything like an empty tank is pushed over a mine field its wreck will block the path to following tanks almost as effectively as a mine. Probably a combination of wall and mine field will be most effective. Such an obstacle will be necessary along the vital portions of a frontier and probably round all important centres of communication and all strategically important points within 200 miles of the frontier or more.

It is pointed out that all this does not affect the principles of war. In the past when infantry was the main attacking arm we opposed to infantry the obstacle of fire power and barbed wire. Now that tanks are likely to become the main attacking arm, we must still oppose an obstacle, but a material obstacle, to enable us to concentrate tanks to hold up and counter-attack the opposing tanks while the mechanical resources of the country are being mobilized.

But these new obstacles, ditches, walls, and minefields, must be constructed largely in peace time and are, therefore, permanent fortifications.

The idea of a long barrier wall is really not fantastic, as witness the Roman wall in North Britain and the Great Chinese wall. In any

case it seems possible that the expense of such an obstacle would be less than the expense of the alternative, the permanent presence of enormous masses of tanks and anti-tank weapons on the frontier.

Now to consider how the tank of the future may affect the British Isles.

It is not extravagant to suppose that in the future we shall find ourselves threatened with tank carrying ships, possibly submersible, which will approach our coasts and disgorge fleets of tanks capable of floating and self propelling in the water. The landings will be carried out at night or under cover of smoke and will be aimed at our naval bases, ports, railway junctions near the coast, etc. It appears as though we should have to provide points of this nature with anti-tank fortification. At any rate, the possibility is worth considering.

The tank which has been discussed in this article is the cross country fighting machine. There will also be, however, cross country tractors for the carriage of stores, infantry, guns, etc. These also will add to the rapid offensive power of an army. Any obstacle which will stop these tractors or even confine them to a few defiles will add enormously to the power of defence by delaying the attack.

THE WORK OF THE ROYAL ENGINEERS IN THE EUROPEAN WAR, 1914—1919.

BRIDGING.

APPENDIX.

Formation of R.E. Bridging School.

1. The introduction into the British Army in 1915 of steel bridge spans, composed of sections of light weight for transport facilities, was an innovation which necessitated the training of Officers, N.C.O.'s and men of the Royal Engineers in their use and erection.

All bridge spans were originally landed at Havre, and it was decided to form classes of instruction in the erection of these bridges there, under the R.E. Stores Officer.

Eight courses were arranged at Havre and 86 officers and 281 N.C.O.'s and men were given practical instruction in the erection of steel spans, and timber piers and abutments.

It was found, however, that this arrangement was unsatisfactory since it entailed much extra work for the Staff of the R.E. Base Park, and the classes could not be held as frequently as was necessary to train a sufficient *personnel* to deal with the large amount of Bridging which obviously might at any time become an urgent service.

It was therefore decided in 1916 to establish a School of Instruction in Bridging in an Army Area, and to hold classes regularly during the Winter months.

Choice of Site.—Accommodation.

2. The considerations which governed the choice of a suitable site were :—

(i.) The school should be near a convenient rail centre, so as to facilitate transport of bridging material, and of the *personnel* of the classes.

(ii.) It should be near the canal system of the Armies.

(iii.) A suitable stretch of river, some 200 yards in length and about 60 feet wide, was required, with sufficient ground adjacent to it on which to build the spans and launch them.

(iv.) The river should be 6 to 8 feet deep, and have a fair current in order to give facilities for the erection of piers, etc., under the conditions usually met with in the Field.

(v.) Sufficient accommodation should be available near the site for the Staff of the school, and the *personnel* of the classes.

(vi.) There should be good facilities for entrance and exit of transport conveying bridging material.

In October, 1916, several sites were visited and reported upon by the newly appointed Commandant, and it was finally decided to establish the School at Aire on a by-pass of the River Lys.

The ground available was low-lying, but there existed a good stretch of water on which there was no canal traffic.

The site was excellent for the erection of bridges, though the transport facilities were not good, but the latter was not a matter of great importance at the time, since the quantity of material to be kept at the School was small.

Accommodation.—Accommodation for the Staff was arranged in billets in the town, and the *personnel* of the classes was accommodated in barrack barges on the river.

Barge bridging Depôts had been formed in 1915, and some of the barges so used were converted for use as barrack barges, the stores and bridge spans which they contained being unloaded and used at the school.

In October, 1917, a hutted camp was built at the site of the school for the accommodation of the Staff. This was much more satisfactory than billets in the town.

Dining Hut.—In November, 1917, the efficiency of the school was greatly increased by the addition to the accommodation of a large hut 90 ft. by 30 ft. This was used as a lecture room for N.C.O.'s and men, and as a dining hut. It was erected near the existing cook houses so that meals were better served than in the barges.

This hut also enabled better instruction to be given to N.C.O.'s and men; diagrams of bridges were exhibited in it, and men could work there in their squads at schemes and exercises, and be visited by the Assistant Instructors.

Owing to the difficulty experienced in working on sodden ground during the winter of 1916–17 the bridging ground was, in October, 1917, covered with a layer of six inches of shingle. This greatly improved the site, and the men had always a dry ground to work upon even in bad weather.

Removal to new site.—The school was situated at Aire during the winters of 1916/17 and 1917/18.

Early in 1918, owing to the great increase in the amount of material which it became necessary to stock at the school in order to give instruction in all branches of the subject, it was found that the limited facilities for transport and handling of material at Aire were a serious disadvantage, and in April, 1918, the German advance made it imperative to evacuate all bridging stores from Aire. It was therefore, not considered advisable to re-establish the School there, and in August, 1918, a fresh site was selected.

Site at Monchy Cayeux.—The Communal ground at Monchy Cayeux on the River Ternoise was chosen. This site was eminently suitable for the work required. There was a large area of ground available with good soil for anchorages, etc., and plenty of room for the erection of large spans.

The river itself was only 22 ft. wide and 2 ft. 6 in. deep, but the width between banks, which were 5 ft. to 7 ft. high, varied between 70 and 100 feet.

In order, therefore, to provide a sufficiently large water gap, a timber dam was constructed below the bridging ground and the level of the water raised by 4 feet.

The design of the dam is shown in *Plate* XXXII. The construction of it provided useful experience for the first class at the School in October, 1918.

This gave a water gap of 60 feet with sufficient depth to float pontoons.

Camp.—A suitable field existed for a hutted camp.

The *personnel* of the Staff and of the Classes was therefore accommodated in huts, which were found much more satisfactory than the barges at Aire.

A plan of the R.E. Bridging School as it existed at Monchy Cayeux is given on *Plate* XXXIII.

Sports.—The surrounding country at Monchy Cayeux provided better facilities for games than existed at Aire, and a football ground, tennis courts, and a golf course were constructed.

DEVELOPMENT OF STAFF OF THE SCHOOL. WAR ESTABLISHMENT.

3. (*a*) *Original Staff.*—The Instructional Staff at the opening Classes consisted of :—

Commandant and Chief Instructor	1
Instructors	2
Adjutant and Assistant Instructor	1
N.C.O. Assistant Instructors	3
Clerk	1
"B" *Personnel* for Camp Duties	12

(*b*) *First Increase.*—As the courses developed and the number and variety of steel spans increased, this staff was found insufficient to give all the instruction necessary to fully cover the ground, and an increase was made.

The Establishment authorised under War Establishment No. 652 dated 15/8/17, was as under :—

Detail.	Personnel. Officers	Warrant Officers.	Staff Sjts. and Sjts.	Rank and File.	Total.	Remarks.
Commandant and Chief Instructor. (*a*)	1	...	...	...	1	(*a*) Major R.E.
Instructors. (*b*)	2	...	...	...	2	(*b*) 1 Capt. R.E.
Adjutant	1	...	...	...	1	
Coy. Serjt. Major		1	...	...	1	
Coy. Qr.Mr. Serjt.			1	...	1	
Assistant Instructors			3	...	3	(*c*) "B" *personnel.*
Storekeeper			...	1	1	
Clerk			...	1	1	
General Duties (*c*)			...	22	22	
Total ...	4	1	4	24	33	

(*c*) *Second and Final Increase.*—This Staff was sufficient to deal with the work done during the Winter of 1917–18, but in October, 1917, the number of different types of bridges had doubled, and there were no less than 24 different types in which detailed instruction had to be given, in addition to steel cube piers, piles, trestles and other bridging expedients.

In addition to the practical work, it was realised that very much more detailed instruction was required in Reconnaissance, Organisation, and Design.

Schemes (as set forth in another paragraph) had to be given to Officers and their solutions fully discussed with them.

The necessity of ensuring a high standard of efficiency at the school was realised as a result of the bridging work carried out during the autumn of 1917.

Application was therefore made for an increase in the Establishment, which was authorised under War Office letter 121/France/1407 dated 16/12/17.

The War Establishment of the R.E. Bridging School, France, as authorised under War Establishments Part VII A. No. 990, is :—

Detail.	Personnel. Officers.	Warrant Officers.	Staff Sjts. & Sjts.	Rank & File.	Total.	Motor Cycles.	Bicycles.	Remarks.
Commandant and Chief Instructor (*a*).	1	...	...	...	1	...	...	(*a*) Major R.E. or Lt. Col.
Instructors. (*b*) ...	3	...	...	...	3	(*c*) 1	(*d*) 11	(*b*) Capts.R.E.
Adjutant	1	...	...	...	1	...	...	(*c*) with side car.
Senior Assistant Instructor. (*e*) ...	...	1	...	...	1	...	...	(*d*) for students
Coy. Serjt. Major ...	...	1	...	...	1	...	...	(*e*) W.O.Cl. 1.
Coy. Qr.Mr. Serjt. ...	...	...	1	...	1	...	...	(*f*) Includes 1
Assistant Instructors	...	...	6	...	6	...	...	Cpl.and 2
Corporal	...	...	...	1	1	...	...	Sappers
Storekeepers ...	...	...	...	(*f*) 3	3	...	...	(*g*) Sapper.
Clerks	...	...	...	(*f*) 3	3	...	...	(*h*) Includes
Draughtsman (Mech.)	...	...	...	(*g*) 1	1	...	...	Lce.Cpl.
Privates. (*j*) ...	...	...	...	(*h*) 33	33	...	...	(*j*) "B"
Batmen. (*j*) ...	...	...	...	5	5	...	...	*Personnel*
Total ...	5	2	7	46	60	1	11	

Supersedes W.E. No. 652.

War Office, (S.D.2.).
15th February, 1918.

The rank of Lieutenant Colonel was approved for the Commandant of the R.E. Bridging School under War Office letter 121/France/2578 (S.D.4) dated 13/8/18.

Composition and Duration of Classes.

5. When the School opened at Aire in December, 1916, each class consisted of 20 Officers and 100 N.C.O.'s and men. This figure was found the most suitable for working and was not altered subsequently.

Usually one-third of the *personnel* was drawn from Field Companies in the B.E.F., and the remainder from Army Troops and Tunnelling Companies R.E., Officer students included Field Engineers and representatives from the D.G.T.'s Branch. During 1916/17 the duration of each course was 10 working days.

As the work developed and increased it was found that in a course of 13 days the instruction had to be so concentrated, and there was so much to be got through, that it was thought advisable to further extend the course to 20 working days. This course was much more satisfactory, and was adopted in 1918. It gave the students more time to assimilate the lectures, and more time to devote to their schemes and exercises.

Special Course.—Early in 1917 after six ordinary courses had been completed, it was thought that a nucleus of specially trained Officers and N.C.O.'s should be available in each Army for bridging work.

It was therefore decided to hold, in March 1917, a special long course of one month, the class consisting of promising students of the previous courses, and officers who, in the appointments they held, would probably be called upon to do bridging work.

This course was composed of 12 Officers and 36 N.C.O.'s, and was held concurrently with Classes Nos. 7 and 8, which were of the usual size.

The special training included advanced instruction in design, erection and handling of the various types of spans.

Organisation of Classes.

6. For administrative purposes and for practical work the classes were divided into 10 squads of 10 men each. The ten squads were organised into five groups of 2 squads each.

A Serjeant Instructor was put in charge of each group, and was responsible under the Senior Assistant Instructor for the instruction of the group.

The Senior N.C.O. of each squad acted as squad leader during the course; his duties were to organise the work of his squad, especially the indoor work in the execution of schemes and exercises, and to arrange discussions of the various problems among the members of the squad.

The Assistant Instructors of each squad attended these discussions to answer questions and explain difficulties.

The N.C.O.'s of each squad were detailed as squad commanders in practical work in rotation, so that each N.C.O. would get practical experience in organising a small squad of men on bridging work.

An Officer Instructor was in charge of all practical work, and prepared the design of the bridges erected and programme of work, which was explained to all ranks before commencing.

The working hours were from 8 a.m. to 12 noon, and from 1 p.m. to 4 p.m. Lectures to N.C.O.'s and men were delivered during these hours; these lectures were generally of half an hour duration, and the remainder of the day was devoted to practical work on the ground.

For practical work officer students were put in charge of a group of two squads daily on the work, each officer being on group duty for three days consecutively, so that he could, as far as possible, carry out each scheme from the beginning till completion. These officers were required to take charge of the parties on the work, and to superintend N.C.O.'s and men of the class under the supervision of the officer in charge of practical work.

For indoor work on schemes and for reconnaissance work, the Officers' Class was organised in syndicates of two officers; one solution being called for from each syndicate.

Syllabus of Course of Instruction.

7. As the number of steel bridges increased, so the syllabus of instruction at the school expanded.

New types of bridges were designed and ordered from England, and new methods of erection devised.

By February, 1918, however, samples of all the new types of bridges had been delivered at the school and erected, so that it was necessary subsequently to amend the syllabus.

The course was divided into :—

(i.) Practical Work.
(ii.) Lectures, indoor work, and Reconnaissance.

(i.) The practical work consisted of the erection of spans, construction of trestle and cube piers, pile-driving heavy and light, launching of heavy girders, use of derricks, tackles, pontoon rafts for pile-driving, etc., and in short, all operations likely to be required for bridging work in the Field were practised.

(ii.) *Lectures, etc.*—There were 20 lectures delivered to officers of each class.

These included a complete course of 8 lectures embracing organisation of bridging work, description of type spans, supply of materials and transport, bridging dumps, etc.; three lectures in reconnaissance including aerial reconnaissance, three lectures on piles and abutments, three lectures on tackles, anchorages and launching, one lecture on simple applied mechanics, and two lectures on special types of bridges.

In addition to these lectures officers were shown on the ground the details of the various spans, one type being taken at each lecture which lasted 20 minutes.

There were four exercises and two schemes issued to each Class.

The exercises were simple applications of the principles taught in Lectures and practical work, and included designs for a pile pier, a trestle pier, a short span bridge and tackles required for launching main girders of stock spans.

The first scheme embraced the reconnaissance of an existing bridge with a view to determining what loads the bridge would take.

There were 12 lectures delivered to N.C.O.'s and men of each class.

These were of a practical nature, and included the description of such practical details of the work as N.C.O.'s and men would require in the field.

There were three schemes issued to N.C.O.'s and men.

One solution was required from each squad, the members of which worked together and discussed the problem among themselves.

The scheme included taking sections of gaps, an easy reconnaissance scheme for the reconstruction of a short span bridge, and an exercise in the organisation of working parties on bridge erection.

A typical programme of a course at the School is attached. (Schedule A.)

LIBRARY.

8. In order to encourage study of the various branches of bridge engineering a library was formed at the school in October, 1917.

Standard books of reference on bridge engineering were obtained, and issued to officers of the classes.

On arrival all officers were issued with a copy of the " Memorandum

on Road Bridges," pamphlets on the Inglis and Hopkins Bridges and "Portable Road Bridges."

The squad leader of each squad of N.C.O.'s and men was also issued with a copy of these publications.

Material.

9. In order to make practical work as complete as possible, it was necessary to have in stock at the School, at least one span of each type in use with the Army.

The following is a list of the stock spans normally held at the school during 1918, which were erected and launched during the courses.

120 ft. Type Hopkins Bridge, 120 ft. Span.	1.
75 ft. Hopkins (Type) 90 ft. Span.	1.
85 ft. Class A. Span.	1.
60 ft. Mark II. Span.	1.
60 ft. Class A. Span.	2.
30 ft. Class A. Span.	1.
30 ft. Reinforced Span.	1.
21 ft. 6 in. Portal Lifting Bridge.	1.
21 ft. 6 in. Davit Lifting Bridge.	1.
21 ft. 6 in. Pont Levis Lifting Bridge.	1.
21 ft. 6 in. Class A. Span.	1.
21 ft. 6 in. Mark II. Span.	3.
16 ft. Mark II. Span.	1.
16 ft. Class A. Span.	1.
Inglis Rectangular Bridge, 72 ft. Span.	1.
Inglis Medium Type.	1.
Inglis Light Type (Twin Bridge).	1.
Sankey Pontoon Bridge (84 ft. length).	1.
20 ft. R. S. J. Field Bridge for Tanks.	1.
18 ft. R.S.J. Field Bridge for Tanks.	1.
20 ft. R.S.J. Field Bridge for 12 T. axle	1.
60 ft. Class B. Bridge	1.
30 ft. Class B. Bridge.	4.
13 ft. Class B. Bridge.	1.

In addition to the above material, the stores for an Army Bridging Depôt were kept in stock; these stores provided sufficient launching gear for use of the Classes, and a large stock of timber for piers, etc., was also held.

Examination and Reports.

10. For the classes held during the winter of 1917/18 and in the autumn of 1918, a report on each officer, N.C.O. and man was made at the end of each course.

Officers were marked for their ability in practical work as group officers, and a verbal examination was carried out by the Commandant at the end of each course.

All exercises and schemes were marked and a percentage mark was arrived at for each officer in practical work, design, reconnaissance and organisation.

Officers were graded as to their capabilities for bridging work in accordance with the following standard :—

General qualifications for employment on Bridging Work.	Practical.	Design.	Reconnaissance.	Organisation.
	Per cent.	Per cent.	Per cent.	Per cent.
Specially Recommended ...	80	80	80	80
Recommended	70	70	70	70
Recommended for a Subordinate position, on Bridging work	60	50	60	60

Any officer not obtaining the qualifying minimum of marks in any subject as above was reported as " Not recommended for employment on Bridging Operations."

In the case of N.C.O.'s and men, marks for practical work were allotted by the Assistant Instructor in charge of practical work and the Commandant.

All N.C.O.'s when acting as squad commanders, were inspected and marked by the Commandant on their ability to command.

Marks for organisation and reconnaissances were given by the Commandant in a verbal examination held at the end of the class.

This verbal examination included questions on practical work given with a view to testing the man's powers of observation and the organising of parties, and, in general, on the students' knowledge of the work done during the course.

The following minimum marks were required for the qualifications stated :—

Qualifications for Bridging Work.	Practical.	Organisation and Reconnaissance.	
	N.C.O's. and Sappers.	N.C.O's.	Sappers.
	Per cent.	Per cent.	Per cent.
Very superior	90	80	75
Superior	80	70	60
Skilled	50	50	40
Not Recommended	under 50	under 50	under 40

COMPETITION BETWEEN SQUADS.

11. In each class a spirit of competition was engendered among all ranks.

Squads were marked collectively for the work done during the course.

The squad marks were calculated by averaging the marks obtained by N.C.O.'s and men of the squad in practical and oral work, and adding the marks obtained by the squad in the schemes carried out by them, as described above.

The marks of the best squad of the class were published in School Orders on the last day of the Class.

The names of the best serjeant, best corporal and the best sapper of the class, and marks obtained, were read out on the last parade of the course, and they were congratulated by the Commandant.

Their names were published in orders, and also the marks obtained by each N.C.O. and man of the Class.

RECORDS OF *PERSONNEL* TRAINED IN BRIDGING.

12. A record was kept on a card index system of all officers passing through the school, giving the marks obtained in each subject and the Commandant's recommendation.

From the index to these cards it could be seen at a glance the number of officers trained in each Army and in each Unit. A similar card was kept for each N.C.O. and man.

These cards were kept " by units," so that it could be seen how many men had been trained in each Unit.

The index gave a cross reference for each N.C.O. and man by means of a serial number, so that any N.C.O. or man who had attended the school could be traced.

NUMBERS TRAINED.

13. 1916/17.—During the winter of 1916/17 the number of—

(*a*) officers, N.C.O.'s and men trained at the School were :—

Officers	150
N.C.O.'s and Men	806

The average number trained in each Army was 29 officers and 160 other ranks.

(*b*) 1917/18.—In 1917/18 the number trained were :—

Officers	166
N.C.O.'s and Men	861

The qualifications obtained by the officers were :—

Specially recommended for Bridging Work	20
Recommended	46
Recommended for a Subordinate Position	60
Not recommended	40
Total	166

The qualifications obtained by N.C.O.'s and men were :—

Very Superior for Bridging Work	48
Superior	169
Skilled	593
Not recommended	51
Total	861

The distribution of this *personnel* among Units was as follows :—

Field Companies	64 Officers and 269 Other Ranks.
Army Troops Companies ..	53 Officers and 407 Other Ranks.
Tunnelling Companies ..	28 Officers and 88 Other Ranks.
Other Units such as Cavalry Corps, H.Q.'s of Formation, D.G.T. etc. ..	21 Officers and 97 Other Ranks.

There were 156 Field Companies represented, 60 Army Troops Companies, and 28 Tunnelling Companies.

Taking the Session 1917/18 as typical of the distribution of students between Units, it will be seen that the average number of all ranks trained in each Field Company was two, in each Army Troops Company eight, and in each Tunnelling Company four.

The training of such a small number of other ranks in Field Companies would not have much effect, but for a Field Company Commander to possess an officer trained in heavy bridging is valuable.

It is to be noted also that many Army Troops Companies sent a large proportion of their men to the school, especially those units which more or less became specialists in bridge erection.

(*c*) 1918.—During the autumn of 1918, before the cessation of hostilities the following numbers of officers and men were trained at the school :—

Officers	33
N.C.O.'s and Men	173

The qualifications obtained in the case of the officers were :—

Specially recommended	4
Recommended	15
Recommended for a subordinate position	12
Not recommended	2
Total	33

The qualifications obtained by N.C.O.'s and men were :—

Very Superior	17
Superior	42
Skilled	114
Total	173

(*d*) *Total Trained.*—Including the courses at Havre, it will be seen that the total number trained in heavy bridging from 1915 to 1918 was 435 officers and 2,121 other ranks.

In addition to these numbers, which were trained in the regular courses, there were held at the bridging school both during the summer of 1917 and the summer of 1918 short courses for officers and men in special bridging work in preparation for operations.

Approximately 20 officers and 250 other ranks received instruction of this nature.

REMARKS ON STANDARD OF WORK AND RESULTS OBTAINED.

14. (*a*) *Officers.*—Officers attending the courses were expected to have had some knowledge of the general principles of bridging as laid down in Military Engineering Part III., Sections III., IV. and V.

The general standard of Engineering knowledge of officer students was, however, not as high as it might have been, but nevertheless they took a keen interest in the work, and learnt a good deal about bridging during the short course which they had.

It was invariably noticed that those who were backward at the beginning improved considerably towards the end of the course.

Design and organisation were the chief stumbling blocks, since the majority of students were young Officers.

The percentage qualifications of the best Officers' Class was:—

Specially Recommended	16%
Recommended	48%
Recommended for a Subordinate position	32%
Not recommended	4%

The large number of students of the school who were employed on Bridging work during the advance in the Autumn of 1918, and the success of those Bridging operations are sufficient justification for the existence of the School, and the results of the instruction thereat.

(*b*) *N.C.O.'s and Men.*—The standard of work shown by N.C.O.'s and men was excellent, and above the expectations of the Instructional Staff at the School.

The men were all very keen on the work, and greatly appreciated and benefited by the individual instruction which it was possible to give with the additional staff provided in November, 1917.

The answers given by N.C.O.'s and men in their verbal examination by the Commandant showed that they had worked hard during the courses, and had exercised their powers of observation to a remarkable degree.

The general inference to be drawn from this result is that the secret of training in bridge work is to provide a sufficient staff of capable instructors to give considerable individual attention to all students at the school.

Research and Experimental Work.

15. Careful records were kept at the school of the practical work done, and of the man-hours taken to erect the various types of spans.

These results were incorporated in the revised edition of "Memorandum of Road Bridges" written by the Staff of the School, and published in 1918.

New methods of erection were devised and experimented with, and new appliances for use with the various spans and for pile-driving were tested, and improved upon until they were suitable for use in the Field.

The results of these experiments were incorporated in the text book mentioned above.

Visits of Officers of Allied Armies.

16. In 1917/18 short visits of French and American officers were arranged at the school.

The work in progress was explained to them, and lectures were delivered in their own language.

Notes were also issued giving a description of the various bridges and the conditions governing their use in the Field, and details of the practical work carried out each day.

Reconnaissance of Existing Bridges in Army Areas.

17. In the execution of the schemes set them officer students made a reconnaissance of many bridges in the neighbourhood of the school.

The results of these were tabulated, and further reconnaissance work was done by the Staff at the close of the courses.

The loads which these bridges would take were then calculated and tabulated, and the results distributed to the formations in whose area the bridges were situated.

These notes were found to be of great value in subsequent operations, notably during the German advance on the Lys in April, 1918.

During the Summer of 1918, some of the Staff of the School were employed on a reconnaissance of all bridges in the area occupied by the British Army. The load for each bridge was calculated and the results published.

ERECTION OF BRIDGES IN THE ARMY AREA BY THE CLASSES.

18. In connection with the preparation of the defensive line in the Lys area in February and March, 1918, it was required to considerably improve the road communications in the Army area.

Some of the new bridges required were within reasonable distance of the school, and as the work of the erection of these spans was of a very suitable description for instructional purposes, it was decided to erect them with the classes at the school.

No. 8 Class erected two Lifting Bridges over the River Lys south of Armentières.

The general type was a Pont Levis bridge supported upon pile piers in the centre of the river, and short spans on pile abutments on either side.

It was arranged for the piles to be driven by the Inland Water Transport who had near the sites suitable plant for the purpose.

Another bridge of a similar type, but with only one pile bent at each abutment, was erected at Merville over the River Lys.

Time for Erection.—In the case of the two bridges south of Armentières the spans for each bridge were erected in three working days of 8 hours each by the N.C.O.'s and men of the classes, under the supervision of the Staff of the School assisted by the group officers of the class.

The spans of the Merville bridge were erected in two working days.

These times were believed to constitute a record for bridges of this type, and demonstrate that with good organisation, steel bridges can be erected in a very short space of time.

Inglis Bridges.—A number of foot bridges were also required over the River Lawe in connection with the defence scheme.

The spans erected in each case were Inglis medium type bridges, of lengths varying from 48 feet to 72 feet.

No. 8 Class erected nine of these bridges in one working day of 10 hours, a notable achievement since the bridges were distributed over an eight miles length of the river.

ERECTION OF BRIDGES IN ARMY AREAS BY THE STAFF OF THE SCHOOL.

19. After the German advance in the Lys sector in 1918, a large number of bridges were required in the First and Second Army Areas near Aire.

A portion of the Staff of the school was retained after the close of the ordinary courses at the school, to assist with these bridges. Forty-five bridges of various spans were erected under the supervision of the Staff. Also a number of spans were prepared and stocked for use in the event of an advance.

The labour employed was usually supplied by Formations in whose area the bridges were required.

ORGANISATION OF THE SCHOOL AFTER CESSATION OF HOSTILITIES.

20. The R.E. Bridging School was re-organised in December 1918, to take courses of 20 regular officers in bridge engineering and construction, in place of the ordinary classes of 20 officers and 100 other ranks.

The syllabus of these new courses includes applied mechanics, masonry structures, timber design, design of steel bridges and roof trusses, reinforced concrete and reconnaissance.

SCHEDULE A.

PROGRAMME OF WORK.

NO. 1 CLASS—OCTOBER, 1918.

1. PRACTICAL WORK.

Bridges to be Erected:—

No. 1. 120-ft. Hopkins on ¾ T. bankseats.
2. 85-ft. Class "A" (on girder only).
3. 75-ft. Hopkins on ¾ T. bankseats.
4. 60-ft. Mark II. on ¾ T. bankseats.
5. 30 ft. Reinforced and 22 ft. R. S. J. Field Span for Tanks, with Cube pier.
6. 60 ft. Mark II. and 20 ft. R.S.J. Field Span for Tanks with Cube Pier.
7. Pont Levis, 21 ft. 6 in. Class "A," and 16 ft. Mark II., with 2 pile piers.
8. 22 ft. R.S.J. Field Span for 12 T. Axle load on ¾ T. bankseats.
9. 20 ft. R.S.J. Field Span for Tanks on ¾ T. bankseats.
10. 25 ft. Bridge for First Line Transport.

Construction of Dam on R. Ternoise:—

SPECIAL WORK.

Date.	Group.	Squads.	Bridge No.	Work.
20th Oct. 1st day	1	A.B.	Dam.	Erecting 2 piledrivers and staging for same, transporting, preparing and driving piles.
	2, 3, 4	C. D. E. F. G. H.	No. 4	Preparing bankseats and launching tackle. Erecting Girders.
	5	J. K.	No. 7	Erecting piledriver and staging for same, transporting, preparing and driving piles.

Date.	Group.	Squads.	Bridge No.	Work.
21st Oct.	1	A. B.	Dam.	Driving 2 piles.
2nd day	2, 3, 4	C. D. E. F. G. H.	No. 4	Complete erection of steelwork and preparations for launching.
	5	J.	No. 7	Driving 1 pile.
		K.	No. 1	Excavation for bankseats and setting out.
22nd Oct.	1, 3, 5	A. B. E. F. G. J.	No. 4	Launching and decking.
3rd day.	2	C. D.	Dam.	Driving 2 piles.
	4	H.	No. 7	Driving 1 pile.
		K.	No. 1	Preparing bankseats and erection packings.
23rd Oct. 4th day.	1—5	A—K.	No. 1	Erecting steelwork.
24th Oct. 5th day.	1—5	A—K.	No. 1	Erecting steelwork.
25th Oct. 6th day.	1—5	A—K.	No. 1	Erecting steelwork.
26th Oct. 7th day.	1, 2	A. B. C. D. G. H.	No. 1	Completing bankseats and erecting launching gear.
		E. F.	Dam	Driving 2 piles.
	3	J.	No. 10	Erecting.
	5	K.	No. 7	Driving 1 pile.
27th Oct. 8th day.	1, 2, 4	A. B. C. D. G. H.	No. 1	Completing launching arrangements.
		E. F.	Dam.	Driving piles.
	3	J.	No. 10	Completing.
	5	K.	No. 7	Driving pile.
28th Oct.	1—5	A—K.	No. 1	Launching.
9th day.	1	A. B.	No. 9	Transporting material and excavating bankseats.
	2	C.	No. 7	Driving pile.
		D.	No. 5	Erecting cube pier.
	3, 5	E. F. J. K.	No. 1	Fixing roadway and removing launching tackle.
	4	G. H.	Dam.	Driving piles.
29th Oct.	1	A.	No. 9	Completing.
10th day.		B.	No. 8	Erecting and Completing.
	2	C.	No. 7	Driving 1 pile.
		D.	No. 5	Erecting cube pier.
	3, 5	E. F. J. K.	No. 1	Fixing roadway and removing launching tackle.
	4	G. H.	Dam.	Driving 1 pile and fixing wales
30th Oct.	1	A.	No. 8	Removal and Re-erection.
11th day.		B.	No. 9	Removal and Re-erection.
	2, 4	C. D. G. H.	No. 1	Completing approaches.
	3	E.	No. 7	Driving 1 pile.
		F.	Dam.	Fixing wales.
	5	J. K.	No. 5	Assembling and launching 30-ft. Reinforced.
31st Oct. 12th day.	1—5	A—K.	Inglis Rectangular.	
1st Nov. 13th day.	1, 5	A. B. J. K.	No. 4	Dismantling decking and withdrawing.
	2	C.	No. 9	Removal and re-erection.
		D.	No. 8	Removal and re-erection.
	3	E. F.	No. 5	Erection of 22 ft. R.S.J. Span.
	4	G. H.	No. 3	Excavating for bankseats and setting out.

Date.	Group.	Squads.	Bridge No.	Work.
2nd Nov.	5	A. B. J. K.	No. 4	Dismantling complete.
14th day.	2	C.	No. 8	Removal and re-erection.
		D.	No. 9	Removal and re-erection.
	3	E. F.	No. 6	Erecting and placing cube pier.
	4	G. H.	No. 5	Withdrawing 30 ft. Reinforced.
3rd Nov.	1	A. B.	No. 5	Erecting of 30 ft. Reinforced span.
15th day.	2, 4, 5	C. D. G. H. J. K.	No. 3	Erecting steelwork.
	3	E.	No. 9	Removal and re-erection.
		F.	No. 8	Removal and re-erection.
4th Nov.	2, 4, 5	C. D. G. H. J. K.	No. 3	Erecting steelwork.
16th day.	1	A.B.	No. 5	Erecting of 30-ft. Reinforced span.
	3	E.	No. 8	Removal and re-erection.
		F.	No. 9	Removal and re-erection.
5th Nov	1, 3, 5	A. B. E. F. J. K.	No. 3	Erecting, launching gear, launching and fixing roadway.
17th day.	2	C. D.	No. 5	Dismantling 30-ft Reinforced span.
	4	G. H.	No. 9	Removal and re-erection.
		H.	No. 8	Removal and re-erection.
6th Nov.	1, 2, 5	A.	No. 7	Driving 1 pile.
18th day.		B. C. D. J. K.	No. 2	Erecting steelwork.
	3	E. F.	No. 3	Completing approaches.
	4	G.	No. 8	Removal and re-erection.
		H.	No. 9	Removal and re-erection.
7th Nov.	1, 3, 4	A. E. F. G. H.	No. 2	Erecting steelwork.
19th day.		B.	No. 7	Driving 1 pile.
	2	C. D.	No. 2	Erecting launching gear.
	5	J	No. 9	Removal and re-erection.
		K.	No. 8	Removal and re-erection.
8th Nov.	1—5	A—K.	Dismantling tackle and returning to store.	
20th day.	1—5			

2 (*a*). LECTURES—OFFICERS.

Date.	Day of Class.	Subject.
Oct. 20th.	1	Types of Stock Spans, Army Bridge Depôts and Base Park.
		Hopkins Bridges.
21st	2	Piles and piledriving.
		Bending Moments and Shear.
22nd	3	Preliminary Reconnaissance and Reconstruction Schemes.
		Short Span Bridges for Heavy Loads.
23rd	4	Piers and Abutments, Part I.
		Piers and Abutments, Part II.
24th	5	Supply of Materials and Transport.
		Launching Methods.
25th	6	Organisation of Bridging Work on the site.
		Tackles and Anchorages, Part I.
28th	9	Aerial Reconnaissance.
		Tackles and Anchorages, Part II.
29th	10	Description and details of canals and streams in enemy territory and preparation of forecasts of Bridging requirements.
		Examination of Bridge Spans.
Nov. 1st	13	Organisation of a R.E. Coy., for Bridge Work.
		Inglis Bridge.
2nd	14	Preservation of Timber, Metal Work and Stores.
		Army and Corps Bridging Dumps.
3rd	15	Organisation and Equipment of I.W.T., Salvage Units.

N.B.—The first lecture will be at 11.30 hours daily and the second lecture at 17.00 hours.

2 (*b*). LECTURES—N.C.O.'S AND MEN.

Date.	Day of Class.	Subject.
Oct. 20th	1	Types of Stock Spans. Piers and Abutments, Part I.
21st	2	Hopkins Bridges. Tackles and Anchorages.
22nd	3	Organisation of Bridge Work, Part I. Piers and Abutments, Part II.
23rd	4	Organisation of Bridge Work, Part II. Manipulation of Heavy Loads.
24th	5	Transport. Bridging Stores and Tools.
25th	6	Inglis Bridges.
26th	7	Sections of gaps.
28th	9	Reconnaissance and simple reconstruction.

3 (*a*). SCHEMES OR EXERCISES—OFFICERS.

	Issue.			Handing in.		
Date.	Day of Class.	Hour.	Exercise or Scheme.	Date.	Day of Class.	Hour.
Oct. 21st	2	12.30	Design of Pile Pier.	22	3	20.00
22nd	3	18.00	Design of Short Span Bridge for Tanks.	23	4	20.00
23rd	4	18.00	Design of Trestle Pier.	24	5	20.00
26th	7	08.00	Preliminary Reconnaissance Scheme for half Class.	28	9	20.00
27th	8	08.00	Preliminary Reconnaissance scheme for half Class.	29	10	20.00
28th	9	18.00	Design of Launching Tackle.	½ Class on 29th, ½ Class on 30th.	10 11	20.00
30th	11	08.00	Bridge Inspection Scheme for half Class.	Nov. 1st	13	20.00
31st	12	08.00	Bridge Inspection Scheme for half Class.	2nd	14	20.00

3 (*b*). SCHEMES OR EXERCISES—N.C.O.'S AND MEN.

	Issue.			Handing in.		
Date.	Day of Class.	Hour.	Exercise or Scheme.	Date.	Day of Class.	Hour.
Oct. 23rd	4	08.30	Organisation Scheme.	25	6	18.00
26th	7	08.30	Sections of Gaps.	27	8	12.00
28th	9	08.30	Reconnaissance and Reconstruction Scheme No. 1.	30	11	18.00
29th	10	08.30	Reconnaissance and Reconstruction Scheme No. 1.	31	12	18.00

NOTE.—A Table of Contents and list of plates, etc., of the Bridging Section will be issued in an early number of the *R.E. Journal*.

(Previous articles under the heading of "The Work of the Royal Engineers during the European War, 1914—19" appeared in the *R.E. Journals* of September, 1919 (Introduction p. 105; Anti-Aircraft Searchlights, France, p. 106; Postal Section—Army Postal Services, p. 114), October (Bridging, Chapter I., p. 162), November (Bridging, Chapter II., p. 200), December (Bridging, Chapter III., p. 261), January 1920 (Bridging, Chapter III., (*continued*), p. 13), February (Bridging, Chapter IV., p. 61; Organization of Engineer Intelligence and Information, p. 79), March (Bridging, Chapter V., p. 149). Copies of these Journals may be obtained through the usual channels.)

PLATE XXXII.

REPORT ON R.E. BRIDGING SCHOOL.

PROPOSED DAM AT R.E. BRIDGING SCHOOL.

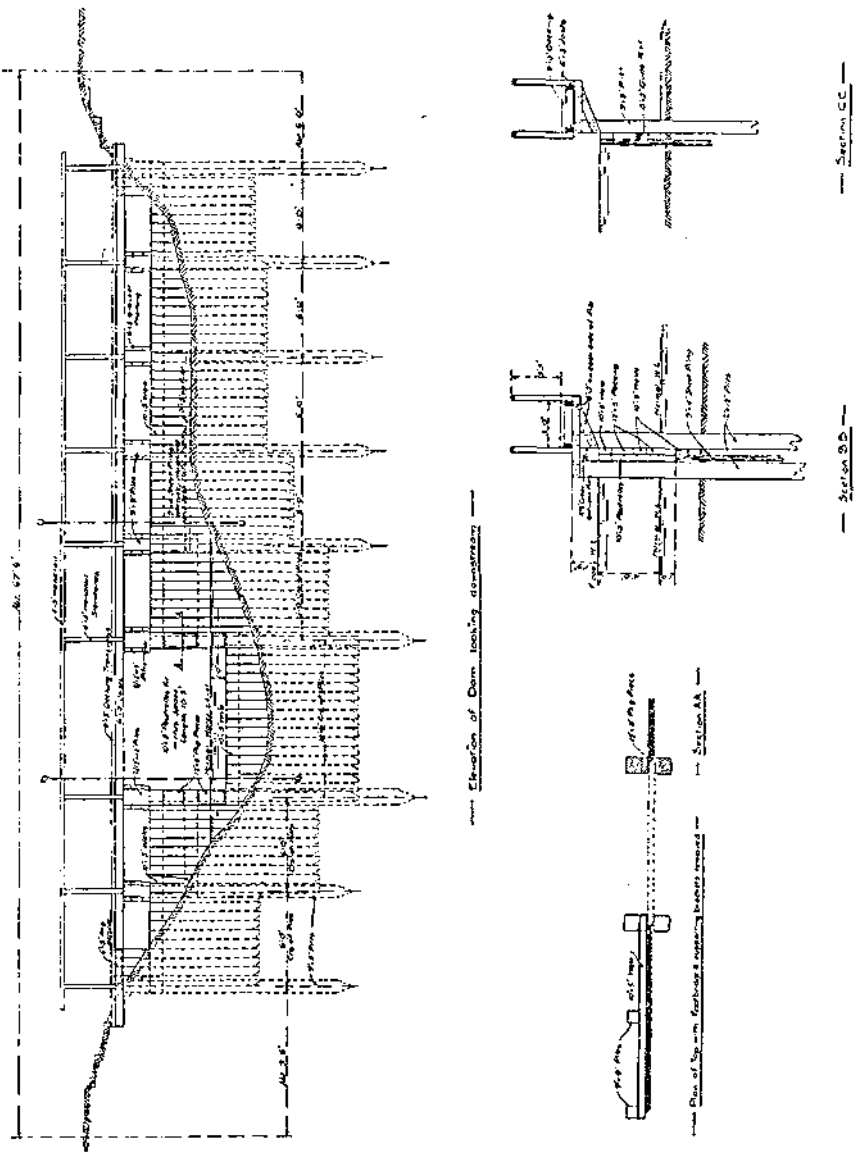
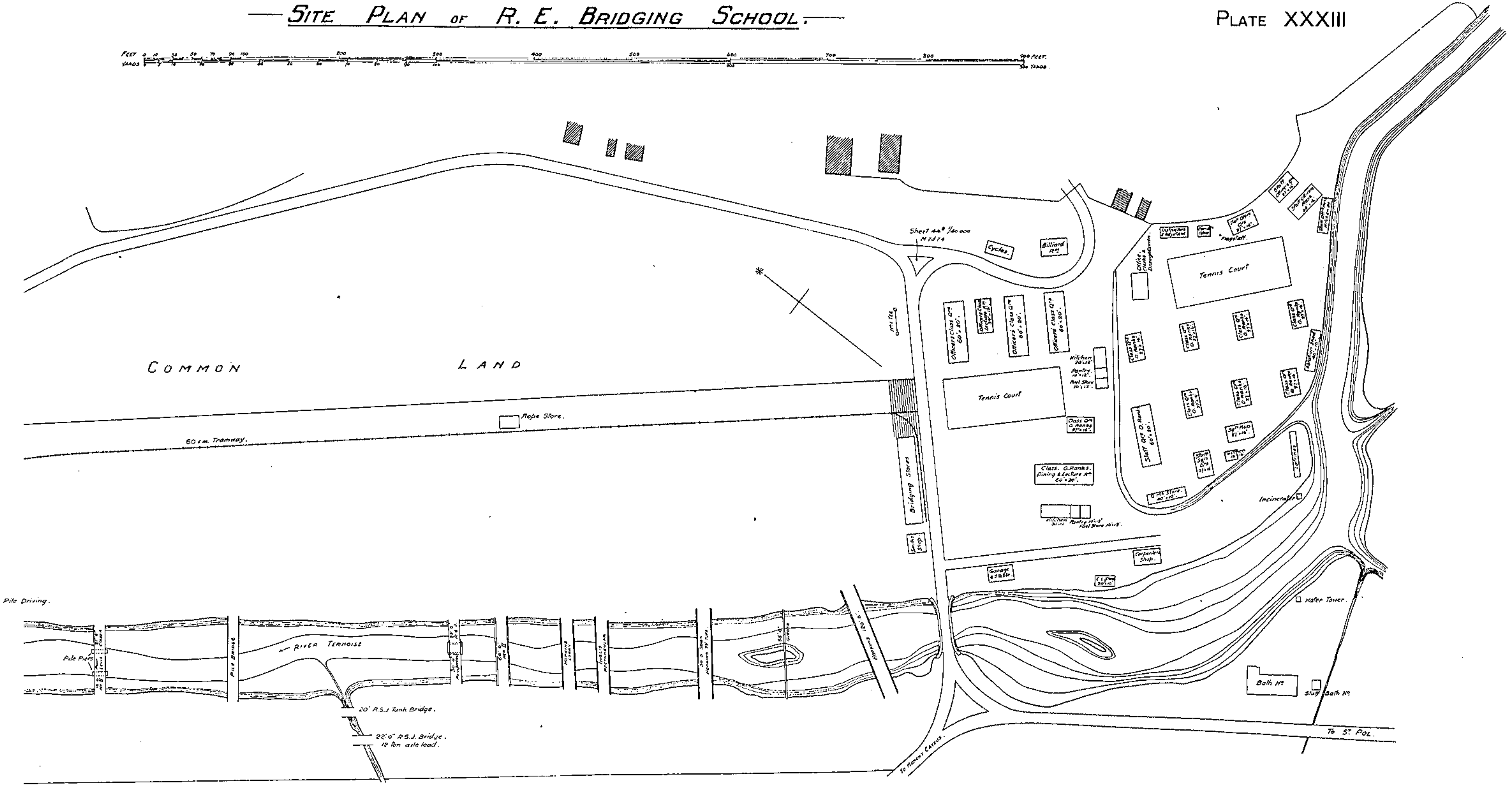


Plate XXXIII

Site Plan of R. E. Bridging School.



THE BATTLE OF ARRAS.

REPORT ON R.E. PREPARATIONS FOR THE OFFENSIVE OPERATIONS ON 9TH APRIL, 1917,

By the C.R.E., 3RD DIVISION.

1. The 3rd Divisional Headquarters arrived at Warlus on 11th February and from two days after that the R.E. preparations may be said to have commenced.

The situation of R.E. and Pioneer *personnel* then was :—

56th Field Company R.E., just arrived at Arras.

438th (Cheshire) Field Company R.E. and 20th Battalion K.R.R.C. (Pioneers)—less 100 men employed on bunking barns—had been in Arras a few days, working under 12th Division.

529th (E. Riding) Field Company R.E., 2 sections at Warlus erecting Divisional Headquarters. One section at Wanquetin with 50 Pioneers erecting Nissen huts. One section at Liencourt bunking barns.

2. *Hutting.*—The hutting may be dealt with in a few words. The scheme was to increase the accommodation in the back area by erecting Nissen huts and bunking barns.

Shortness of material, largely due to thaw precautions being in force, delayed this considerably. Roughly speaking two sections of the 529th (E.R.) Field Company and 100 Pioneers were employed on it continuously from about 12th February to 5th April, and during that period erected :—

At Wanquetin	84	Nissen huts
At Liencourt	12	,, ,,
At Warlus	15	,, ,,

While 1500 bunks were constructed and 500 repaired in various villages.

3. *Preparations for the Offensive.*—These may really be said to have started on 15th February. Some two or three days were spent in finding out what was actually required, as the ideas of the 3rd Division did not agree altogether with those of its predecessor. Two excellent systems of tunnels made by the New Zealand Tunnelling Company, joining up various caves, were approaching completion, and full advantage was taken of the safe communication they afforded, the Brigade and Battalion Headquarters being made off the tunnels and thus provided with safe communications.

The main items of work then decided upon were roughly :—

(*a*) Four main communication trenches 'Imperial,' '20th Street,' 'Iceland' and '1st Street.'

(*b*) Three Brigade Headquarters.

(*c*) Four Battalion Headquarters for 76th (front) Infantry Brigade.
Three Battalion Headquarters for 9th Infantry Brigade.

(*d*) Trench mortar emplacements for five Batteries of 2" T.M.'s.

(*e*) Circular trench and Cable trench to give lateral communication.

The above works (*a*) and (*e*), C.T.'s and lateral communication, were allotted to the Pioneers.

Each Field Company constructed the Headquarters for its affiliated Brigade.

Two Battalion Headquarters were constructed by each of the 56th and 468th (Cheshire) Field Companies.

The three Field Companies had nominally about 100 Infantry working with them up to about the middle of March, when the number was gradually reduced.

Other items taken in hand later on were :—

In the Ronville system of caves (to be used for assembling the 8th Infantry Brigade) the Pioneers constructed deep latrines, urinals and ablution benches, water being laid on by the VII Corps. Aladdin's Cave, found by accident by the Pioneers when digging the Circular trench, was cleared and three entrances were made into it, so that it could be used as a 'Q' dump, and some fifty pack animals stabled in it.

Three bridges, fit to carry any traffic, were made on roads where the Cable trench cut across them, by the 56th Field Company.

Advanced Divisional Headquarters.—A suitable site for these had to be found and gave some trouble. Eventually it was decided to utilise Russell Cave. This when cleared by the N.Z. Tunnelling Company was found to provide very little accommodation. The same Company then constructed a new dug-out close by which took all the Advanced Divisional Headquarters, except Signals, orderlies and officers' mess, which were placed in the old cave. The fitting up of this Headquarters was carried out by the 56th Field Company.

T.M. Emplacements.—One section of the 438th (Cheshire) Field Company was detailed for this as soon as it arrived in the area, and remained continuously at it, with working parties of R.A., T.M's and Infantry. Two sections of the 56th Field Company were also employed later on for a short period.

Originally five Batteries of Medium T.M.'s were to have been constructed, but owing to the retirement of the enemy from the front

of our right most of these became useless, and eventually only five 2″ T.M.'s were used, besides Heavies.

4. *R.E. Dumps and Stores.*—An old workshop alongside the Girls' School was selected as the main R.E. Dump. The accommodation it afforded was limited, and later on as material came in another dump called Reserve Dump was formed on the Rue de Rietz.

The Pioneers established a dump of their own in the Rue du Temple.

Two advanced dumps were formed, well forward, just before operations commenced, one close to the original front line by 15th Street, the other just west of Strafe Wood.

The supply of materials at first was slow and scanty, partly on account of deficiency of transport, as thaw precautions prevented lorries from running for a considerable period, and partly due to a scarcity of materials, particularly of sawn timber and tools. It can hardly be said however that work was ever appreciably held up for want of materials (this does not apply to hutting) something which could be made to do was usually obtainable.

By zero day difficulties had been overcome and the dumps could be considered as fairly well stored.

Trench bridges and Trench ladders.—600 of each were obtained from the Army Parks. This number appears to have sufficed.

Artillery Bridges.—24 were obtained which sufficed.

The *tools* issued for the assault to the different Brigades were as follows :—

8th	Infantry	Brigade	300	picks	500 shovels
9th	,,	,,	490	,,	980 ,,
76th	,,	,,	,,	,,	1000 ,,

Q and Brigade Dump.—The Divisional Advanced Q Dump was in Aladdin's Cave, into which three entrances had been made, one of them large enough to admit pack animals, which were stabled in the cave until required.

Two or three of the old shafts were also fitted up with windlasses for hoisting or lowering stores. Water was laid on into this cave for filling petrol tins

Brigade dumps for S.A.A., grenades, etc., were made off the tunnels mostly by the Brigades themselves with R.E. supervision and assistance.

6. *Roads.*—(*a*) The main road in this area was the Arras-Cambrai road, a first-class *pavé* road, but cut about in our area by several trenches, three barricades, shell-holes, etc.

(*b*) Along the southern boundary ran a track, metalled for the first 500 yards to a very limited extent. Beyond that it was only a mud track.

The XVIII Corps undertook to make good the Cambrai road

up to our front line, which they did, except that our Pioneers did the final filling-in of trenches and demolition of barricades.

They also undertook to make it good on the day of the battle up to just by the first German trench. Beyond this point up to the Bois des Bœufs had to be made passable for transport as quickly as possible.

The Intelligence regarding this portion gathered from aeroplane photographs showed that nine trenches crossed it and that certainly one large pit, probably 25 feet wide, and six feet deep, had been dug right across it; possibly also two others, and two barricades also existed at Tilloy. This intelligence proved fairly correct, but the barricades were destroyed by artillery fire. Only one pit was found and this was more of the nature of a very wide trench with a barricade of agricultural implements, and it was not so wide as anticipated. To deal with this road one section 529th (E.R.) Field Company and the 20th K.R.R.C. (Pioneers) (less 1½ platoons) were detailed, with the Pioneer Battalion of the 37th Division as second relief and the N.Z. Tunnelling Company and one A.T. Company R.E. as third relief.

The scheme was, briefly, for the section R.E. to erect a trestle bridge over the pit, using one of their Weldon trestles and superstructure for the purpose, this being carried up by hand. All other trenches to be filled in and corduroyed with sleepers. A single track for horsed transport to be got through first, and then widened, made fit for lorries, etc.

Tools were collected and about 2500 sleepers, supplied by the Chief Engineer VI Corps, disposed in dumps by the Pioneers.

All parties of the 20th K.R.R.C. were *very* carefully organised, told off each to a definite trench, and tools and materials allotted beforehand.

On the 9th April at 9.15 a.m. the liaison officer of the XVIII Corps was ordered to commence work on his portion. At 9.25 a.m. the first company of the Pioneers was ordered to move up, but on reaching the spot found it too hot to work for another two hours, and suffered ten casualties. The remainder of the Battalion, and the section of the 529th (E.R.) Field Company were ordered up at 1.30 p.m., and got on all right with the work.

A track ten feet wide and fit for lorries (it is doubtful if this was the case at the trestle bridge) was reported through at about 10.0 p.m. on the 9th.

On the 10th the Chief Engineer VI Corps assumed charge of the road.

The track along the Southern Divisional Boundary was wanted to enable Field guns to get forward. 1½ Platoons of the 20th K.R.R.C. (Pioneers) were allotted to this. Trenches were prepared for bridging and material collected. This party under Lieut.

Thomas was ordered up at 9.15 a.m., and the track was ready by the time the guns arrived. Continued heavy traffic, coupled with wet weather, destroyed it and it became hopeless unless corduroyed throughout. No more sleepers were available for it after the 12th. A good deal of work was done on it by the Field Companies in the meantime, but it dropped out of use.

Two level crossings were made just north and south of Arras Railway Station in case either of the bridges was destroyed, and in order to provide additional road facilities. Their value was fully proved when the bridge north of the Station blew up.

Allotment of R.E. and Pioneers for the Offensive.—The three Field Companies were allotted for work on 9th April as follows :—

With the 76th I. Brigade.—2 Sections 529th (E. Riding) Field Company with two platoons 2nd Battn. Suffolk Regt. Half a section and one platoon Suffolks were employed in improving the Push Pipe crater just south of the Cambrai road for use as a C.T., and on digging through the lip into a German sap. The Push Pipe was exploded at 5.30 a.m. and formed a crater about 15 feet deep. At first there was a considerable amount of shell-fire here and the casualties amounted to 5 R.E. (20 per cent.) and three Infantry.

At 9.5 a.m. these Sappers moved forward to join the other 1½ sections in constructing strong points in the German first line system. The platoon finished the C.T. by 1.0 p.m.

The two sections altogether constructed three strong points on the 9th and another on the 10th.

With the 9th I. Brigade.—56th Field Company and two platoons of Infantry attached. Three sections with an Infantry party constructed three strong points in the Harp, east of Tilloy and west of the Quarry. The 4th section erected a screen on the Cambrai road on the night 8th—9th to cover the advancing battalions from view from the north, and afterwards examined German dug-outs and put a well in Tilloy into working order. Casualties 1 officer and 2 men wounded. The strong points were completed by 4.30 p.m. On the 10th April the Company was employed in wiring the Blue line.

With the 8th I. Brigade.—Two sections 438th (Cheshire) Field Company and two platoons 1st Battn. R.S.F. These were moved up at noon on the 9th, but as the Brown line had not been captured they were sent back again. On the 10th they were again sent forward and after the capture of the Brown line constructed two strong points in it. Later on they cut gaps in the wire for cavalry to pass through. Casualties 3 wounded.

Of the remaining R.E., one section of the 529th (E.R.) Field Company was employed in erecting the trestle bridge in the pit on the Cambrai road, as has already been mentioned. The remaining section of this company and one section of the 438th (Cheshire) Field Company were employed in the evening of the 9th on the South

Artillery track, the remaining section of the 438th being detailed for fire duty in Arras.

On the 10th these three sections were all employed on the South track. On the 11th, 12th and 13th all the three Field Companies were employed on the South track, except that on the 11th and 12th the 529th (E. Riding) stood by for 48 hours in the Bois des Bœufs ready to consolidate Guemappe when taken, and on the 13th two sections of the 56th Field Company acted similarly In neither case were they used.

When not at work the Companies lived in their cellars in Arras.

The employment of the Pioneers was entirely on roads and has been already described. In addition, on the night 8th—9th a hundred of them were sent off to dig out five Tanks which had stuck near the Citadel. They succeeded in freeing three of them.

No particular new lessons are apparent, but the value of the careful and thorough preparations, which worked without a hitch on the day, must be recognised.

SOME MORE BOOKS ON THE WAR.

By BRIG. GENERAL J. E. EDMONDS, C.B., C.M.G.

THE list of books mentioned in this article is of course by no means exhaustive, and the writer would be glad to hear of others of value that any R.E. officer may come across.

FRANCE.—Some very valuable books on the operations of the early part of the war have appeared in Germany. These are the "Die Schlacht bei Mons" (2·30 marks) in the series of German General Staff Monographs published by Stalling. Even without a knowledge of German, the maps which show the advance of von Kluck's divisions, and the plans of the battles, will tell the military student a great deal. In the same series "Die Schlacht bei Longwy" gives a truthful account of the fighting of the German Fifth Army and entirely disposes of the Crown Prince's claim to a victory.

A translation of "Ypres" (5s.) has already been noticed in the *Journal*.

Another very important book is "Mein Bericht zur Marneschlacht" (9 marks) by Generaloberst von Bülow. It describes the operations of the First and Second Armies, both of which were most of the time under his command, from the commencement of the campaign until the end of the Battle of the Aisne. It is indispensable to the student on account of the operation orders and maps. There are also a somewhat fuller story, "Die Marneschlacht 1914" by General-major Baumgarten-Crusius (5 marks), which covers the same period, and the story of the German Third Army by its Commander General Oberst von Hausen:—"Erinnerungen der Marnefeldzug 1914" (24 marks). The maps, etc., in the above books enable the campaign up to the Aisne to be followed in detail, and make General Sir F. Maurice's clever patchwork in his "First Forty Days" obsolete. Von Kluck's Memoirs are in the Press and a translation is being prepared by Messrs. E. Arnold & Co.

Of French books, "Le Revers de 1914 et ses Causes" (4·50 francs) by Col. de Thomasson and "L'Erreur de 1914" (4·50 francs) by General Berthaut give a clear account of the reasons for the French plan of campaign and the opening moves. "Le Vérité sur le Siège de Maubeuge" (3 francs) by Commandant Cassou has an authoritative account of the siege by a staff officer who was present. "Le Rôle de la Cavalerie Française" (4·50 francs), by J. Hethay presents a good picture of the activity of the French cavalry and

particularly of the raid on to the German L. of C. during the battle of the Marne. "Lille" (4·50 fr.) by General Percin explains why, by order of the Government, Lille was not defended.

For the closing phase of the campaign there are Major Gen. Sir F. Maurice's "The last four Months (7s. 6d.) which also deals with the causes of General Sir H. Gough's defeat, and a very similar book in French "La Bataille Decisive" (3 francs) by Capitaine R. Hoff.

MESOPOTAMIA.—One is glad to be able without partiality, favour or affection to place Major E. W. C. Sandes' book "In Kut and Captivity" (24s.) among the best books on the war. His clear and unpretentious narrative gives the military history of the campaign from just after the victory of Shaiba until the surrender of Kut, and narrates his subsequent captivity. As commander of the Bridging Train he tells us a good deal of special engineer interest. Mr. Candler, who was an official press correspondent, in his "Long Road to Baghad" (2 vols. 40s.) practically carries on the story from the time Major Sandes leaves off. Like the road he describes, the book is somewhat long, but apart from his complaints of the censorship it is far from wearisome. "In Mesopotamia 1914—5" (9s.) Major Reynardson, who was with the first division that left India for the Persian Gulf, tells an interesting story from the regimental officer's point of view. In "Four-Fifty Miles to Freedom" (7/6), Captains Johnston, R.A. and Yearsley R.E. give a dramatic account of their escape from captivity, good enough from a literary point of view to be reviewed in the *Athenæum*. "The Road to Endor" by E. H. Jones, Lt. I.A.R.O. (8/6) is a fresh example of the adage that truth is stranger than fiction.

Major General Townshend's book has been appearing in parts in the *Sunday Times* and will no doubt be available shortly in volume form. He is very outspoken in his criticism of the Higher Command.

PALESTINE.—"The Advance of the Egyptian Expeditionary Force July 1917 to October 1918," published by H.M. Stationery Office (6s.) contains a brief military account with numerous excellent situation maps of Lord Allenby's advance, followed by a number of chapters on technical work, including some on R.E. matters. The credit of the success of the campaign is largely given to the R.E. and R.A.M.C. in spite of cavalry having been present.

Major Lock's book "With the British Army in the Holy Land" (7s. 6d.) provides a good deal of local color and sound history. He joined the Palestine force after the first and second reverses at Gaza. A great deal of information will be found in W. T. Massey's two volumes (21s. each) "The Desert Campaign" dealing with the advance from Egypt to Gaza, and "Beersheba to Beeroth—How

Jerusalem was won," A further volume is to describe the great advance.

SALONICA.—"Salonika and After" (10s. 6d.) by H. Collinson Owen, who edited the *Balkan News*, provides a mass of local color and towards the end of the book a short clear sketch of the operations. The beautifully illustrated "Salonika Front" (25s.) painted by W. T. Wood and described by Captain A. T. Mann goes somewhat deeper into the operations.

EAST AFRICA.—Br. General Crowe's "General Smuts Campaign in East Africa" (10s. 6d.) is a good military account of that period. The best book of local color, F. Brett Young's "Marching on Tanga" (10s. 6d.) covers the same time, so one is thrown on despatches at present for the remainder of the campaign unless one goes to the German story. Lettow Vorbeck's own is told in "Meine Erinnerungen aus Ostafrika" (20 marks), which will shortly be issued in an English translation, Dr. Deppe's "Mit Lettow-Vorbeck durch Afrika" (24 marks) is also most valuable; it is full of detail, has 300 illustrations and contains a good account of the original attack on Tanga, where he was in charge of the hospital.

Edmund Dane's volume "British Campaigns in Africa and the Pacific 1914–18" (7s. 6d.) is weak except in the account of the campaign in South West Africa.

GALLIPOLI.—"The Dardanelles" by Major General Sir C. E. Caldwell (18s.) is a valuable addition to the literature of Military History and should be carefully studied. The final report of the Dardanelles Commission (Part II., Conduct of operations, with appendix and maps, 2s. net) is now on sale at H.M. Stationery Office.

NAVAL OPERATIONS.—Sir Julian Corbett's first volume of the official naval history is expected to appear in March. I am informed that Mr. Pollen's "The Navy in Battle" contains a good general account of the war on sea. Of German books there are "My Memoirs" by Grand Admiral von Tirpitz (translated 2 vols., 28s.), probably the most truthful book yet written on the war; and Captain Persius' "Seekrieg" with a bitter attack on von Tirpitz. "The Battle of Jutland" by Commander Bellairs is most interesting, and though necessarily founded on gossip and hearsay, probably, goes very near the truth. "The Dover Patrol 1915—17" (two vols. 34s.) by Admiral Sir R. Bacon is of special interest to soldiers as it tells the story of how the Channel was held, though we shall look with more interest at a book by Admiral Bacon's energetic successor, Admiral Sir R. Keyes, if he ever writes one. One of the most entertaining books on the War is "The Indiscretions of the Naval Censor" (21s.) by the late Chief Naval Censor, Admiral Sir R. Brownrigg.

GENERAL.—Of the many memoirs published, Ludendorff's "My War Memoiries 1914–18" (translated 2 volumes 34s., in German

one volume 18 marks), and Falkenhayn's "General Headquarters 1914—1916 and its Critical Decisions" (translated 24s., in German 18 marks) are disappointing; they go very fully into the successes in Russia but say little about the West; in fact Ludendorff stops short of the preparation for 1918, and Falkenhayn only gives 3½ pages to the Battle of the Somme and about 7 to Verdun. Lord Haldane's "Before the War" (7s. 6d.) clears up his relations with the German Court before 1914, but tells us little of what he did as War Minister to prepare the Army for the inevitable war.

Some other books of interest are Count Czernin's "In the World War" (translated 25s.), the memoirs of a very cynical diplomat; "A Private in the Guards" (10s.,) by Stephen Graham, a much discussed book which relates the experience of rough handling suffered by a temporary soldier as a recruit, and his life at the front; and "the Press in War Time" by the late Sir Edward Cook, co-director of the Official Press Bureau. A book called "Sapper Dorothy Lawrence" should be noticed; the lady's only claim to the rank she uses is that a friendly Tunneller provided her with uniform and she got up to the front for a day.

TECHNICAL.—The only technical book that has come to notice is "Le Service des Routes Militaires 1914—19" (5 francs) by Lt. Col. Lorieux, Assistant Chief of the Service of Military Roads. It contains an excellent account of the French system with reproductions of photographs of roads, quarries, bridges, etc. and maps.

THE SIGNAL SERVICE WITH THE EGYPTIAN EXPEDITIONARY FORCE.

Reproduced with the sanction of the Controller of H.M. Stationery Office from "A Brief Record of the Advance of the Egyptian Expeditionery Force, July 1917 to October 1918" :—

A BRANCH of the Royal Engineers that merits a separate chapter is the Signal Service. The nature of the operations, the rapid and wide movements, and the great distances traversed, which have been special features of our operations in Palestine, made the problems of intercommunication peculiarly difficult. The sharp changes from soft sandy deserts to rolling pasture land passable by wheels, and then to mountain tracks where lines could be laid only by hand, and material conveyed by pack animals, called for much elasticity in transport, and ingenuity in methods of building telegraph lines. The necessity for long distance speech from the front to the base required the provision of telephone trunk lines as long as from London to Aberdeen. The volume of traffic to be dealt with has involved the use of delicate apparatus for high-speed automatic telegraphy, under very trying conditions of dust and damp; and its successful employment is entirely due to skilful handling by the telegraphists, and to the watchful tending of the instrument mechanics.

An expeditionary force operating in such varying circumstances necessarily has to undergo many changes in organization, and each alteration in the organization of a force involves corresponding changes in the means of communication. Not only does this apply to actual lines and offices, but to the organization of signal *personnel*. On the formation of the XXth and XXIst Corps, new companies and sections to meet the demands of these headquarters were necessary, and to a great extent were improvised locally. This improvisation has certain advantages, *e.g.*, the officers and men are accustomed to local conditions but, on the other hand, the older units have to suffer from the withdrawal of officers and men. Besides these major changes in organization, there are always others going on, due chiefly to an ever-extending line of communication, but also to additional means of signalling such as pigeons or "trench" wireless and to the re-grouping of units and formations. This all means, that, while the Signal Service is functioning as a whole, the parts are constantly being altered and improved, and the smooth working of the machine must go on owing to elasticity of the organization and the adaptability of individual members.

The system of intercommunication built up to July, 1917, con-

sisted of: (1) the tactical cable and airlines between East Force Headquarters and the battle front, which included special artillery, Royal Flying Corps and other circuits; (2) the main backbone of semi-permanent lines connecting East Force Headquarters (near Deir el Belah) with the Kantara base (about 140 miles away); (3) the permanent lines within Egypt connecting Kantara to Cairo, Alexandria, Port Said, Suez, and to our cables to Europe, India, and Australia.

During September and October, of 1917 with the prospect of an advance, signal units were very busy—in addition many had only recently been formed, and still had to continue training. Behind the battle area, the increase in administrative services and the doubling of the railway line entailed an expansion of the Lines of Communication Signals. Not only were the local telephone systems continually growing, but means of maintaining telephonic communication with Egypt as the force advanced required the previous building of heavier trunk wires. To economise men, as the lines lengthened, the old Turkish desert telegraph lines had to be replaced by new lines along the railway, where maintenance is easier. Forward units with the assistance of infantry and artillery were engaged on elaborate buried telephone systems in the shelled areas. Alternative routes were so developed that any battery, for example, could always ring up any observation post or artillery commander, even if some of the main lines were cut. Preparations for the attack on Beersheba and the maintenance of communication with the cavalry on their long march of envelopment also involved much careful preliminary work and training. Material for airlines and cables was laid out and concealed ready for rapid laying when the flag fell. Three cables accompanied the cavalry and these were patrolled constantly by horsemen left at test points every five or six miles. Although the lines were cut, one or more of the three were always in working order and communication was preserved throughout the enveloping attack.

When "Z" day arrived and Beersheba was captured, rapidly erected permanent wires were substituted for the long cable lines which had been laid round by way of Asluj. A network of cables spread out from Beersheba to the north and north-west as the flank attacks on the main Turkish positions progressed. When mounted troops advanced, wireless communication came into use to keep touch with the rear. When Gaza fell, lines were rapidly extended up the main road and along the railway. Gaza, Beit Hanun, Deir Sineid, Mejdel, each in turn became railhead where local telephonic systems were rapidly installed. Among the troops advancing, divisional and corps signal units were ever at work coping with the constant forward jumps of their headquarters. For two months this process continued in difficult country and during severe climatic

changes. Then, as warfare became less mobile, more elaborate forms of forward communications grew, involving alternative means of all sorts. In rear the railway and its telegraphs advanced, and as Ludd became railhead there grew up the usual telephone system. Jerusalem, Ramleh, and Jaffa were all linked up, and became important centres; while Jericho served as the focus of intercommunication for the operations across the Jordan.

During the summer of 1918, while big changes in the constitution of the force were in progress some signal units had largely to help units of other arms who were short of trained signallers in maintaining their telephonic systems. Assistance was also given in the training on a large scale of regimental signallers in Corps Signal Schools. A very large increase in the number of signallers was effected in Indian Army units. The more prosaic side, such as the improvement, and in some instances multiplication of lines in rear, and the transmission of masses of telegrams, numerous telephone calls, and messages by despatch rider, went on continuously through 1918.

Early in September, preparations had to be made for the final battle of the war with the Turk. The wonderful secrecy of all the preliminary arrangements necessitated limitations to the amount of work that could be done in certain directions. On the other hand, considerable scope to ingenuity was given by opportunities for misleading the enemy. For instance, the leaving of signal stations in their old places, the continuation of work as usual and the building out of dummy lines, and special telephone exchanges built only for purposes of deception, helped to mask our intentions.

Finally, when the cavalry had moved across to the left flank and all was ready, the " break through " was effected. As is well known, the advance of the cavalry averaged some sixty miles during the first twenty-four hours. As soon as the cavalry divisions got to their positions across the line of retreat of the Turks at Afule and Beisan, telegraphic communication was established between these points and General Headquarters near Ramleh by rapid building and repairs to Turkish lines. Thus the movements of cavalry working northwards from Ghoraniyeh and southwards from Beisan—closing the ring—could be co-ordinated. It must not be forgotten that other forms of telegraphy—visual and wireless—and motor cyclist despatch riders were also playing their important part.

To resume, after the major portion of the Turkish army had been surrounded the freer movements of the cavalry made still greater calls on their signal units. One day's march from Afule led to the capture of Haifa, and, though this was an advance of about thirty miles over new territory, the capture was reported from just outside the town by telephone to the Desert Corps Headquarters at Megiddo (Lejjun) the same afternoon.

During the subsequent advances to Damascus and Aleppo, telegraphic communication to advanced troops was usually obtained as soon as these halted. The method employed was to mount parties of linemen in motor cars with the necessary material and implements, and so effect rapid repairs to existing wires. Subsequently, the patched-up lines have to be thoroughly overhauled, and for many weeks after the army is at rest the cable and airline sections of the Signal Service are kept hard at work re-building, and adding to the telegraph system in the occupied territory.

For those who appreciate figures, it may be of interest to picture the "traffic" dealt with at various places:—

Average number of words telegraphed daily at

(*a*) Divisional Headquarters	12,000
(*b*) Corps Headquarters	25,000
(*c*) General Headquarters	90,000
(*d*) Kantara	60,000

Major-General Sir Philip Geoffrey Twining,
K.C.M.G. C.B., M.V.O.
Director of Fortifications and Works.

Major General Sir Philip Geoffrey Twining

MEMOIR.

MAJOR GENERAL SIR PHILIP GEOFFREY TWINING, K.C.M.G., C.B., M.V.O., DIRECTOR OF FORTIFICATIONS AND WORKS.

By the death of Major General Sir P. G. Twining which, as already reported in the *Supplement to the R.E. Journal* for February, occurred suddenly in London on the 15th January last, the Corps of Royal Engineers lost both its senior official representative at the War Office and one of its ablest officers. It is in fact difficult to appraise the loss suffered. At the present time when the future of the whole British Army is in the making and when wise counsels and clear judgment are vitally necessary to remould the machine to fit in with the new conditions the Corps was indeed fortunate to have such a man as Twining at its head. It will be of interest to all, and we think not without value to the younger Officers, both of this and of future generations, if we trace his career from boyhood, and attempt to discern the forces which moulded the man and to indicate those qualities upon which his success depended. To assist us in this task we have asked his contemporary and lifelong friend, Major General A. C. de L. J. de Lotbinière, C.B., C.S.I., C.I.E., to give some account of his earlier years, and he has kindly supplied the following :—

Philip Geoffrey Twining was born in Halifax, Nova Scotia, in 1862. He joined the Royal Military College, Kingston, Canada in 1880, and graduated in 1883, obtaining a first class certificate which qualified him for a commission, if available, in any branch of the British or Canadian forces.

I cannot say that he took his studies very seriously or that he did more than the minimum amount of work requisite to ensure his successful graduation. To his contemporaries he would be remembered mainly as an outdoor man, taking the keenest interest in all forms of sport. He played full back in the College Rugby team and as an example of his pluck and determination when his collar-bone was badly fractured in an important match he stuck it out to the end thus enabling his side to draw the game. He was also a prominent member of the cricket eleven and excelled at tennis. Though on graduating he had qualified for a commission there was then none available. The only commission given was one to the head of the batch and Twining did not finish more than half way

up his class. It was therefore necessary for him to adopt a profession. I was in the same position and we both decided to take up mechanical engineering. We realised that to attain success practical knowledge and experience were the first necessities, and that we must be in a position not only to order work to be done, but, if necessary, to do it ourselves. We therefore took employment as journeymen fitters in the leading railway shops in the United States and Canada with the object of familiarising ourselves with the details of railway work and practice. The life was in truth not an easy one. In those days work began at 7 a.m. and lasted till 6 p.m. with one hour's break for dinner and no holiday except Sunday. The manual toil was severe and to Twining, who, though physically no weakling was never endowed with a very vigorous constitution, it required great determination to carry on. The conditions were entirely different from those imposed on the educated engineering apprentice in this country and with all their hardness carried advantages that more than compensated. In no other way would it have been possible to arrive at the close knowledge of the rank and file, of their views and their mode of life, knowledge which in after life gave true authority, born of intimate and practical experience. For three years Twining lived this life and moreover entirely supported himself on the pay he earned. The rate was only 2s. 6d. per day for the first year, rising to 5s. 6d. in the third year, a rate obviously insufficient for more than the barest necessities. It was his pride that he cost his father almost nothing during the whole time. On such an anvil was his character forged during the most malleable years of his life.

Late in the autumn of 1885 our chance came and our outlook was suddenly enlarged. At that time this country was going through one of its periodical and probably inevitable war scares and it was decided to make a substantial increase in the establishment of R.E. Officers. Twenty-five commissions were accordingly offered to graduates of the Royal Military College, Kingston, among which Twining and I were fortunately numbered.

I well remember the receipt of this news. We were engaged in re-making a steam joint on an engine, just in off the line. Twining was working in the smoke box, in a condition of heat and dirt which needs no emphasis and I was handing tools to him, when a telegram arrived conveying the joyful intimation that Her Majesty Queen Victoria had honoured us by the offer of commissions in the Royal Engineers. I need hardly say that we had no hesitation as to where our duty and our inclination lay and we quitted our work and our status as workmen possibly without much feeling of regret at the moment but carrying in us a strong conviction, which has deepened as years go by, that we had immeasurably gained by our strenuous experience.

We joined at Chatham in January, 1886, and after eleven months at the School of Military Engineering were considered qualified for foreign service. We both chose service in India and embarked in February 1887. On arrival in India our ways parted and since that date while always keeping up an intimate friendship we did not actually serve together until our return from France in 1918.

Twining's career in India was a varied one and gave him ample opportunities, of which he did not fail to avail himself, of acquiring knowledge of his profession and of the needs of the Army generally. He served for a time in the Bombay Sappers and Miners at Kirkee and was employed on various official services on the North West Frontier.

In 1890 it was decided to make a reconnaissance survey of the route of a railway in the neighbourhood of the Khaibar Pass. The organisation of the survey party and the direction of the operations were entrusted to Major General Sir J. R. L. Macdonald, K.C.I.E., C.B., then Captain R.E., and Twining was chosen as one of his staff. The success of this work led to a similar operation in the Zhob Valley, and, in 1891, to the more important survey of the route of the proposed Uganda Railway, in both of which Twining took part. The history of this last operation is well-known and need not be recounted here.*

On completion of the work he was selected for an appointment on the instructional staff of the Royal Military College, Kingston, and served there in the office of Professor of Military Engineering from September 1892 to June 1898. Here as always Twining threw himself heart and soul into the task at hand and left a fine reputation behind him when he departed. His teaching was animated and inspired by his faculty for grasping essentials and for expressing them in a simple, direct and convincing style. He himself doubtless gained enormously by this experience of teaching and by the valuable practice it gave him of clothing his thoughts in words. The succinctness and clarity of his memoranda and reports, a quality so invaluable to a staff officer and which he exhibited so remarkably when he was called to high office, were largely a fruit of this time.

He returned to India in November, 1898, and from then to 1914 held a number of important posts. In 1900 he proceeded to China with the Expeditionary Force as D.A.A.G. (special service), being twice mentioned in despatches. He was afterwards in succession :— Inspecting Officer Imperial Service Troops Punjab ; A.A.G., Army H.Q. Staff Simla, and Commandant 1st K.G.O., Sappers and Miners, to which responsible command he was appointed while still a Major in the Corps. This post had never before been held by such a junior officer.

* See *R.E. Professional Papers* No. 1 of 1897 (Vol. XXIII.).—Ed. *R.E.J.*

From the foregoing narrative it will be clear that Twining's career in the service for the twenty-eight years from 1886 to 1914, while a distinguished one, was in no way pre-eminently remarkable, nor was it such as to elevate him above many other able and successful men. In his case, as with so many officers, it was the war that really proved him and disclosed of what sterling metal he was fashioned. His career during the war was marked with one uniform characteristic, a complete mastery over all the difficulties of every successive post he occupied. He thus naturally and inevitably rose from post to post, finishing in the highest position our army system offers to the Engineer Officer as such. In 1914 he went to France as C.R.E. Meerut Division afterwards acting as A.Q.M.G. During this early period of the war he took a prominent part, with the Officers of the Bengal Sappers and Miners, in devising and experimenting with a weapon which later attained such importance, the hand grenade. The earlier improvised form, the so called jam tin grenade, was largely due to his ingenuity. The actual construction of such a weapon is however a comparatively small thing. The real advance was to see clearly, even at the very beginning of the trench warfare phase of the combat, that a short range weapon of this class was an absolute necessity and that the army which had one at its disposal must reap a commanding advantage. Twining's clear vision and unerring sense of realities shewed him this and he took every opportunity of forcing upon those concerned the imperative need of starting the manufacture of bombs and grenades upon a very large scale.

On the return of the Indian Division to India he was retained in France and appointed D.A. & Q.M.G., XIII Corps. His services were then specially asked for by Sir E. Geddes for the position of Director of Light Railways and Roads, a post which developed later into that of Deputy D.G. of Transportation, G.H.Q. Finally the last position he held in the field was that of D.A. and Q.M.G., 1st Army.

It is almost needless to say that during the 3½ years that he thus spent in France he was closely engaged in much of the actual fighting. The early time with the Indian contingent covered the whole period of the struggle at Neuve Chapelle. While with the XIII Corps he took part in all the heavy battles on the Somme, in which that Corps was particularly prominent and distinguished. Later on, when serving with the 1st Army, he was present at many of the critical operations during the advance of 1917.

Early in 1918 the office of D.F.W. became vacant and Twining was selected. This selection, being quite outside what would have appeared to be the ordinary lines of promotion, doubtless caused some surprise to those who did not know the man and the character of his work. To those who did know him and who had

watched his steady ascent and seen the splendid adequacy with which he rose to every occasion the appointment was a matter of sincere rejoicing and was moreover patent and clear evidence that no consideration, save the sole one of his fitness for the position, had been given any weight. How amply the selection has been justified is known to all those acquainted with the history of the Corps during the past two years. We are not in a position here to attempt any sort of summary of what he has actually accomplished; in the first place it is too early for such an attempt and in the second, if we read the signs correctly, it is not so much actual accomplishment, his time of office was alas too short for this, but rather that he succeeded in giving things the initial impulse and starting them upon the right roads.

In summarising Twining's character and in estimating the qualities that brought him to the front it will suffice to dwell upon three main points. Firstly we may lay stress upon the uniform equability of his temperament resulting in a delightful courtesy of manner and a rare measure of consideration for the feelings of all those with whom he worked; secondly upon his deep sincerity of purpose and his innate determination never to let anything stand between him and his ideal of duty—he truly lived his life to the full, giving always the best of which he was capable; and thirdly his penetrating insight and power to see realities and disregard unessential details, aided by his faculty for setting forth his ideas in clear and convincing language. His life is full of example and encouragement to others and will we trust long remain an inspiration to the many able young officers that we can fortunately number in the Corps.

Of material rewards and recognition he did not lack. For his services in France he was eight times mentioned in despatches, and received numerous honours, including C.B., Legion of Honour, Grand Cross St. Avis of Portugal, Order of St. Stanislaus—2nd Class, American Military Service Cross, and culminating in the K.C.M.G. At the time of his appointment as D.F.W. he was in a poor condition of health, his exhausting labours had stretched almost to the breaking point a constitution never robust and it was some time before he was sufficiently recruited to assume office. He made however a wonderful recovery and it was hoped by his friends that many years of health and hard work were yet before him. An old trouble however recurred and carried him off with tragic suddenness.

During the time he was on the staff at Kingston he married Miss Louise Daly who survives him. He leaves no children.

In conclusion we may perhaps be allowed to quote extracts from letters which confirm and emphasise the points we have already briefly mentioned.

The Secretary of State for War wrote:—"By General Twining's

death the Army lost a gallant and devoted officer and the State a loyal and untiring servant. His personality endeared him to all who came in contact with him and his presence will be sadly missed."

General Lord Horne wrote:—"General Twining was a man for whom I had the greatest admiration and sincere affection. He was a splendid character, staunch, loyal, true, courteous, kind; a perfect gentleman and a fine soldier. There are few like him."

General Sir W. Furse, K.C.B., until recently his chief at the War Office, wrote:—"Of all the good fellows with whom I have come in contact during the war I never met a man more delightful to work with or one in whom I felt such complete confidence. I had the greatest respect for him and a real affection."

Complete confidence, a deep respect, and a sincere affection were inspired by Twining with everyone with whom he came in contact and what richer praise can we give a soldier and a man?

A. J. DE L.

To the letters already quoted the following two may be added:—

16th January, 1920.

DEAR LADY TWINING,—On behalf of the Corps of Royal Engineers I am anxious to express to you our most sincere sympathy on the death of your husband.

In losing him we have all of us lost a brother Officer who was a friend to each of us and who did his utmost to help the Corps to carry out its work in the best interests of the Service.

We mourn his loss deeply and we desire to share with you a little of the grief which we know is yours.

Yours sincerely,

R. H. H. BOYS, *Brig. Gen. A.A.G., R.E.*

To this Lady Twining replied as follows:—Will you please convey to the Corps of Royal Engineers my sincere thanks for their sympathy in my loss and the deep appreciation I feel at their expressions of affection and appreciation of my husband's work.

REVIEW.

THE DESIGN OF SCREW PROPELLERS FOR AIRCRAFT.

By H. C. WATTS. (Longmans, Green & Co., E.C.4. Price 25s. net.)

The object of this book is to teach the reader how to design a propeller for actual use. Little or no attempt is made to explain complicated theories regarding the subject, practical designing, and the best method of construction, being the chief aim of the author.

Chapter I. gives a statement of the problems involved viz., the designing of a propeller to run at a certain number of revolutions, the points to be considered when designing an efficient propeller, and the best method of designing one which is safe and reliable. The importance of correct design, owing to the greatly differing velocities of revolution and translation required for aircraft, is pointed out.

In *Chapter II.* the general terms and definitions used in propeller design are explained. It should be noted that the author, takes the "Geometrical Mean Pitch," to be the geometrical pitch of a section of the blade at a radius equal to two-thirds of the tip radius, while he defines the "Experimental Mean Pitch" as the distance which the propeller must travel along its axis, in the time taken for one revolution, in order to give no thrust.

Chapter III.—In this it is pointed out, that the blades of a propeller are really aerofoils; and the terms generally used in connection with surfaces of this kind are fully explained. The component re-actions, lift and drag, are discussed, as also changes due to the alteration of the angle of incidence, shape of the aerofoil, cross section, camber, etc., and the VI effect pointed out by Lord Rayleigh. This latter effect is of great importance, as it governs the application of model tests to full sized design and work generally.

Chapter IV. gives an account of the "Simple Drzewiecki Theory" of the propeller. In this the blade is considered to be divided into a number of strips of aerofoil cross-section (so small that all points of a strip have the same velocity) the aerodynamic forces on which are assumed not to interfere with each other's action, and the total power etc., exerted by the propeller is calculated by a system of integration from that on each strip *unit*. The general expressions for torque, thrust, etc. are worked out, and their controlling factors discussed. Explanations of the change in engine revolutions with variation of speed in aircraft, the alterations caused by change of altitude in flight and other questions of importance are given and the chapter closes with a description of the method of measuring the propeller co-efficients under actual flying conditions. It is pointed out that the thrust

co-efficient cannot be obtained from full-sized trials and that model tests in a wind tunnel are necessary to find it.

Chapter V. will be found particularly useful by students, as it gives an example viz.: the analysis of the two bladed propeller AB.7322 under certain given conditions; describes the application of the principles of Chapter IV. to the design of an actual propeller, and discusses the case of a design specified for an altitude.

Chapter VI.—In this the "Inflow" and "Outflow" of the air about a propeller are considered. The former is defined as the velocity of the air from the front which by the time it reaches the plane of rotation, is in excess of that of the surrounding air, while the latter is defined as the excess of velocity of the air affected by the propeller, over that of the surrounding air. An explanation of Froude's theory of the propeller follows and a comparison between it and that of Drzewiecki is made. It is pointed out that both are incomplete, as the former neglects the losses incurred by transforming a torque into a thrust, while the latter omits the inflow velocity of the air. It is further explained that by Froude's theory, the diameter of the propeller should be as large as possible, while by Drzewiecki's it should be as small as it can be conveniently made. The author considers, that Froude's theory is correct (within limits) but suggests that further examination of the subject from the scientific point of view is necessary. He further states that Froude's assumption that the flow of the air through a propeller is approximately stream line appears to be fully justified, and that a combination of the two theories is a reasonable proposition.

In *Chapter VII.* an attempt is made to connect the two theories and to compare the results obtained from the combination with the results of previous calculations. The different values of torque, thrust, etc. are shown by a new set of equations based upon the idea that the inflow velocity (a, V) and the rotational inflow velocity (a_1, V_1) are allowed for, and a general explanation of the system follows. It is pointed out that the rotational inflow velocity must be considered for tail plane and rudder designs, but that in ordinary cases it can be neglected. The author shows that the true efficiency is the product of the Froude and Drzewiecki efficiencies, except that the latter is calculated with the true velocity through the plane of the disc, and not the aircraft velocity. A useful analysis is given in an appendix to the chapter.

In *Chapter VIII.* the question of over-all efficiency is discussed: viz.: the efficiency of a propeller working in an aeroplane which may fly at any of the possible speeds, within its flying limits. The author describes the policy of design, especially in the case of war aircraft when climbing power is of great importance, and shows that the fundamental condition for any design of propeller is (under the given conditions) that it shall not allow the engine to exceed a certain number of revolutions, when that engine is running with a fully open throttle. A mathematical examination of the Primary and Secondary efficiencies (as defined by the author) follows, and the chapter concludes with a calculated example illustrating the ideas developed.

In *Chapter IX.* the flow of air through a propeller is further considered, and also the effect of placing a body in the air stream. As regards the

air flow, it is shown that the air particles follow a spiral path and that this must be taken into consideration. A very full description of some model experiments carried out at the Nat. Physical Laboratory is given to illustrate this question.

The results of experiments on "Mutual Interference" between a propeller and the body of an aeroplane are given, and the reasons why the interference factor is so difficult to estimate are explained.

In *Chapter X.* formulæ for the calculation of the strength of a propeller are discussed and the various stresses to which a propeller is subjected to explained. Fully worked out examples are given, describing both the ordinary and approximate systems of calculation.

In *Chapter XI.* the question of gearing, and the relative advantages of four and two bladed propellers are considered. As regards gearing, the difficulty of estimating the advantages and disadvantages is pointed out, and the general conclusion arrived at is, that for high powered engines with crank speed of from 1800 to 2200 revolutions, gearing is essential, while for low powered engines about 100 HP, gearing is not worth while. As regards four and two bladed propellers, the points for and against each type are summarised and the general conclusion arrived at is, that as a rule the two bladed type is the more efficient, but that the four bladed propeller has certain advantages, such as smoother running and less wear and tear of the engine parts.

Chapter XII.—In this "Tandem propellers" viz.: two propellers working one behind the other are considered. Expressions for Torque, Thrust, etc. are given and the author states that, in practice, it would appear advisable to use the largest possible two bladed propeller in front and the largest possible four bladed propeller in rear, subject to the latter being completely immersed in the slip stream of the former. The subject however requires further investigation as the experiments so far carried out are not at all conclusive.

In *Chapter XIII.* the "variable pitch" propeller is discussed, as also the type of propeller having a variable surface, and the difficulties of designing the latter are pointed out. It is explained that while such propellers have certain advantages they have three great disadvantages, viz.: they give extra work to the pilot, additional control is required and the design and manufacture of the propeller itself is further complicated.

Chapter XIV.—In this the "Hub" is considered and the difficulties met with in transmitting the torque from the propeller shaft to the propeller are explained. The various practical methods of doing this are described.

In *Chapter XV.* the principle of the Windmill is explained, as it is of some importance, on account of its use for transmitting power to the pumps, and generating sets for wireless etc., on an aeroplane.

There are three Appendixes—No. 2 is an interesting "Handbook on the Construction of Propellers."

The book is very well and clearly illustrated.

J. D. Fullerton, *Colonel, R.E. (ret.)*

NOTICES OF MAGAZINES.

THE MILITÄR-WOCHENBLATT.

No. 73.—*The Kraewel Brigade on the 8th and 9th Sept.* 1914.—General Von Kraewel, describes how he, the commander of the 34th Infantry Brigade, was also in command of the main body of the 17th Division, which, early in the morning of the 8th Sept. 1914, had resumed its withdrawal from Montmirail northwards through Chateau-Thierry. At noon, a long halt was made and at 1.45 p.m., while halfway between Mouthiers and Bonnes, he received an order, timed 1.10 p.m., from Von Quast, his Corps Commander, to the effect that 3 hostile columns were advancing northwards between Rebais and Coulommiers, that he was to destroy the bridges and hold the line of the Marne from La Ferté-sous-Jouarre to Nogent, both inclusive, while 3 cavalry divisions held the Petit Morin, and that he was to have 2 Regiments of Infantry, 2 Brigades of Artillery and 1 pioneer company to do it with. The order was, naturally, a considerable surprise to Von Kraewel, also the only map that could be found covering the section of the Marne to be held was a $\frac{1}{500000}$ cut out of a newspaper which an officer happened to have. By good luck the rendezvous, Montreuil-aux-Lions was marked on it. Kraewel collected his infantry and artillery there without mishap, but only by very strenuous marching; the pioneer company never turned up at all. He then decided that he could not hold the actual line of the Marne. It was 7 o'clock, and would soon be dark; the country was intricate and quite strange and he had no maps; his infantry was very tired, and the deep windings of the river rendered it very difficult to hold. He decided to hold the high ground, north of the river, round about Montreuil-aux-Lions and disposed his force on a front of about 5000 yards in such a position that any hostile advance beyond the river would involve a stand-up fight with his whole brigade, firmly established in their chosen position. The destruction of the Marne bridges had to be abandoned owing to the non-arrival of his pioneer company. The night of the 8–9th passed quietly, but at 7.45 a.m. on the 9th British artillery fire opened on some cavalry baggage wagons parked near Porte Ferrée, and soon after the Infantry battle began. At 11.30 a.m., while hotly engaged, Kraewel received orders to co-operate in an attack on the enemy advancing on Chamigny. He replied that it couldn't be done at the moment. The artillery fire increased and he received word that two jäger battalions were coming to help his right flank. These however never got into touch with the Brigade H.Q. At 2.0 p.m. it really looked as if the British were going to rise to the assault. At 2.35 p.m. word came that the 5th Division

was coming to reinforce him and he had hopes of himself being able to attack. Hostile cavalry, advancing through Charly on Villiers, he left to be dealt with by the 5th Cav. Div. which lay, however, rather far back at Marigny. One of his regiments reported it could not hold on much longer; he replied that it must and that the 5th Inf. Div. was coming to help; at the same time he again received orders to attack, but replied that he could not do so till 5th Inf. Div. arrived. Corps H.Q. probably thought this division much further advanced than it really was. At 3 p.m. an Officer of the 19th Cav. Bde. reported that his brigade wanted to attack the rear of the British who were pressing Von Kraewel's right flank. This attack never materialised.

No. 74.—At 3.15 p.m. on the 9th the infantry fighting died down somewhat, but the left flank reported constant attempts were being made to out-flank them, and La Loge was for a time seized by the British, who were, however, shelled out of it. Hostile columns were seen near Bezu but at the same time the head of the long awaited 5th Inf. Div. was reported as having reached half way between Vendrest and Dhuisy. At 4.0 p.m. the situation appeared brighter and the 5th Inf. Div. were nearing Montreuil. It looked as if the time to counter-attack was approaching, but at 6.30 p.m. two things happened. First the British were reported in Marigny, 3½ kilometres N.N.E. of Bde. H.Q. at Ferme l'Hopital, and therefore right behind the brigade, and, secondly, the approaching 5th Div. was seen to stop, assemble and march off towards the north. Shortly after came word that the 9th Cav. Div. was going back to Cocherel, and touch with the 5th Cav. Div., which should have been near Marigny, was lost. The situation was grave; deserted by his neighbours, with both flanks in the air and, in deed, probably surrounded on 3 sides, the Brigade was without orders. Von Kraewel determined to fight on where he was, and to tell his troops nothing of their dangerous situation. At last came an order from the Cav. Corps Commander, Von der Marwitz, under whom he had been placed, to break off the fight and join the 5th Inf. Div. at Gandelu. With considerable skill Von Kraewel slipped out of his position about 8.0 p.m., being obliged however to leave behind him the guns of one battery, which the Infantry tried, without success, to save. The column passed only 2½ kilometres west of Marigny and had a long halt at Prémont 4 kilometres north-west of this village, but was undisturbed by the British. Eventually about midnight 9–10th Sept., it reached Gandelu, where it lay, as its commander says "like dead men," on the road till 5.0 a.m., 10th, waiting for the roads in front of it to clear. By the 12th Sept. it was north of the Aisne, having crossed at Venizel, and in position west of Vailly. Von Kraewel claims that already on the 10th Sept. his men were fit to fight again, and, especially if the masses of cavalry had been used dismounted to help him, could once more have checked the British advance. He says the British tactics were unskilful, but forgets that we were probably even more exhausted with marching than he was. He claims complete success and says that even if he, the 5th Inf. Div. and the Cav. Corps had been completely wiped out, success from the point of view of the 1st Army could still have been claimed. He makes very small mention of the failure to demolish all

the bridges over the Marne, merely hinting that, as he had not got his pioneers, the Cavalry Divisions might better have undertaken this. Possibly if he had told them on the night of the 8–9th how he was situated in this respect, they would have had a try at it, though it is doubtful whether they had, by then, either the time or the material to accomplish much. However that may be it was certainly an agreeable surprise to the British Sappers to find any bridges intact.

Compulsory retirement of active list Officers consequent on the reduction of the Army.—The writer points out how badly treated as regards pensions officers are, compared with officials. He advocates the formation of an officers' union, as the only way in which officers can get their case justly dealt with. Three Situations in Municapilities are offered to ex-officers. Pay from 3000 to 9000 marks per annum.

Roll of Honour Infantry Regt. No. 16—103 Officers and 2871 other ranks killed. Of the Officers, 45 fell in the first 7 months of the war, and 15 at Neuve Chapelle.

No. 75.—*The Fall of Antwerp*, by Gen. Von Zwehl, describes the capture of the city, early in October 1914. The despatch of a British Contingent to help in its defence is discussed and Lord French's opposition to the measure approved. The extent of the Belgian training camps of Beverloo and Braschaet, stated to be considerably in excess of the requirements of the Belgian Army, the design of the buildings, which is said to have been in British *Geschmack* and the presence of British-made instruments in the well-equipped Hospitals of the Fortress, are held to prove that some agreement, to give assistance, had been made by the British Government. Great Britain therefore felt bound to give some, even if only limited, help, which however did not affect the fate of the city.

The bombardment destroyed or damaged about 800 houses in the city and 500 in the suburbs. The greatest efforts are said to have been made to spare the architectural treasures of the place. The demolitions carried out by the Belgians to clear the field of fire of the inner line of forts are deplored, as they were executed in consequence of obsolete defensive principles. The inner line of forts was never defended.

Strength of the German Army.—The distribution of the 200,000 men allowed by the peace treaty as the strength of the German Army is given as follows :

44 Infantry Regts. of 3 Battns. each.	21 Mech. Transport Dets.
23 Cavalry ,,	19 Brigade Bridging trains.
20 Artillery ,,	18 Sanitary Companies.
21 Battalions Pioneers.	20 Headquarter Formations.
29 Communication detachments.	76 Field trains.

No. 76.—*The Fall of Antwerp* (*concluded*) by General Von Zwehl, describes the negotiations for the surrender of the city. The Civic authorities proceeded on their own initiative to the German G.H.Q. at the same time as the latter sent an officer into the town to demand its surrender. They did not meet on the road and Von Beseler refused at first to negotiate ; the bombardment was however suspended and

eventually the German officer returned with a report that the city was no longer defended. Terms of surrender were then dictated and hostages taken. An order by the Belgian Commander, who was captured in one of the forts, to the effect that any persons approaching the Fortress as " Parlementaires " were to be fired on, was discovered. For this, though it admittedly was cancelled almost as soon as issued, the Germans brought him to trial. The proceedings were however dropped " We Germans are not very vindictive in such matters " ! The writer discusses the point as to whether, in view of the comparatively small numbers of prisoners taken (about 5000), it might not have been better to attack from the west and south-west, instead of from the south and south-east. He concludes that, as it was so urgently necessary to remove the threat of the Fortress from the German flank and rear, as the conditions of the ground in the former direction were very unfavourable and as the assailants were in such small numbers compared to the size of their task, the course chosen was the wisest, even if it did allow the bulk of the garrison to escape.

Anti-tank weapons—a defence of the German Authorities against charges of having failed to provide adequate anti-tank weapons in time. The familiar anti-tank rifle, of which 4000 were issued between March and August 1918, weighed 35 lbs. and its steel cored 0·52″ bullet would penetrate at 550 yards 0·8″ of best steel plate. Every pair of anti-tank rifles had a hand cart for them and their ammunition. The Germans had intended to introduce a 0·52″ anti-tank machine-gun and a 1·48″ gun in the spring of 1918, but for some reason not stated, found this impracticable until October 1918 ; in fact they were never used. The writer thinks they would have stiffened the German defence.

Names of Commanders.—The names of the Brigade, Regimental, and Battalion Commanders in the New Army are given, together with their pre-war appointments. Each Regiment is designated as " Reichswehr Regiment No —" and the Brigades as " Reichswehr Brigade No. —" without any territorial or other qualification.

My Report on the Battle of the Marne (1914) by Field Marshal Von Bulow is reviewed at length. The reviewer, referring to the battle as the turning point of the war, says that Von Bülow's order to retire was quite right from his appreciation of the situation of the 1st, 2nd and 3rd German Armies, and that he could not forsee the fateful effect his order would have on the whole campaign. The Supreme German Command failed to give any decision, and it is questioned if Von Moltke was equal to his task. He installed his Headquarters too far away, adequately to control operations under the then undeveloped condition of the communications, but too near Alsace Lorraine, and lost his sense of proportion in consequence. The result was that troops for the East Prussian Campaign were taken from the right wing of the German Army and not from the really comparatively unimportant left wing. Joffre did better. Von Bülow makes it quite clear that the decision to retire was his and his alone, and emphasises his difficulty and reluctance in so deciding, when, so far, he had led his troops to nothing but victory after victory.

With Lettow-Vorbeck through Africa by Dr. L. Deppe, is one of many

German books now appearing on this campaign. The Author is confident that this beautiful colony is not passing for ever out of German hands.

No. 77.—*The leading article*, in reviewing the military and political events of 1919, says that it was nothing but the support of the officers which upheld the government in the early part of the year when civil war raged. It exhorts all officers to do the same again if necessary, however unworthy the government may be and however ungrateful and abusive certain strata of society. Prince Max of Baden is blamed for the collapse of the "Undefeated" German Army, but the Navy comes in for the hardest words. It is despised by friend and foe alike. Abuse of Germany's enemies and sympathy with the even more hardly treated Austria follows and the writer concludes with an appeal to all officers to raise again the high pre-war standard of work and devotion to duty among the officers, so as to ensure that Germany's Army, even if small, is of the best possible quality.

Soviet-Russia, an account of the recent events in Russia, says that at the end of 1919, Bolshevism stands stronger than ever, thanks to the short-sighted, selfish, etc., etc., policy of the Entente. "Lord" Churchill's speeches pointing out the danger, are quoted with appreciation, and the downfall of Bermondt and Von der Goltz, which has rendered it by no means certain that Bolshevism will stop at the Baltic States, is attributed to British intrigue.

French Phantasies is the heading of quotations from French papers about the "Secret German Army."

Roll of Honour—Infantry Regiment No. 26—A supplementary list of 8 Officers killed.

L. CHENEVIX-TRENCH, *Major, R.E.*

REVUE MILITAIRE SUISSE.

No. 11.—November, 1919.

THE FIRST BATTLE OF THE MARNE.

Lieut. Colonel Poudret, the author of the original article, tells us that by degrees Germany is being enlightened as to the true facts of the First Battle of the Marne. For many months after the defeat of the Kaiser's hosts, the public of the Central Empires had been led to believe that the Battle was merely an affair entered into incautiously by the German A.G., and that the small bodies of German troops, which had crossed to the S. of the Marne, on coming into contact with superior forces, had succeeded in retiring without suffering serious loss. A long silence ensued in relation to the details of the struggle on the river: it had been hoped by the German leaders that in the event of a successful issue of the war, this ugly reverse would have been readily forgotten in the Fatherland. But the authorities failed to reckon with those of an inquisitive turn of mind, with those who were discontented with the conduct of affairs and with those who were well informed on the situation.

When the War was found to be dragging on, the significance of this initial check came to be duly appreciated in Germany, and the anger of the public against those who were guilty of deceiving them grew to serious proportions. A scape-goat was wanted: and to this fact was it due that an attempt was made to explain matters. Then von Moltke was removed from his position and died shortly afterwards; von Kluck was also attacked, and attempted a defence of himself. Later, it was the III Army, the Saxon Army, which was held partly responsible for the disaster; and this it is that has caused General Baumgarten-Crusius to publish his *Die Marneschlacht*, 1914, a work founded on official documents.

The III Army has also been violently criticised for the part it played at the Battle of Mons; it has been reproached in respect of its late arrival on the Meuse (*vide* Hanotaux's *L'Enigme de Charleroi*). It had been intended that, in the operations on the Meuse and the Sambre, the III Army should constitute the "surprise element." It was to this Army that the task had been allotted of cutting the communications of the French Army or Armies, which the Great General Staff had hoped to have lured on to Namur. The caution of Marshal Joffre prevented the Saxons from scoring; only the 5th French Army advanced as far north as the Sambre. General Baumgarten discloses the vexation experienced in the German Camp at this failure to bring off a big *coup*; he accuses the French of having deserted their Allies, who are said to have, in consequence, abandoned their plans. "*The dream*," he says, "*of a joint invasion of the Rhine provinces vanished away.*" It can well be understood that the Saxon Army is not willing to accept responsibility for the miscarriage of the German plans: in the early phases of the War and during the Battle of the Marne, this Army found itself in an extremely delicate position.

The III Army had, moreover, from the very beginning been much weakened. Its XI A.C. had been withdrawn first for the investment of Namur and was later sent to Russia. Its Cavalry Division had also been despatched to the Eastern Front, and no mounted troops were allotted to replace it, in spite of repeated representations on the subject. Being sandwiched between the II Army on its right and the IV Army on its left, the Saxon Army was being continuously, and with great insistence, called upon for assistance by its neighbours, but often without justification. In consequence, its troops were frequently unnecessarily scattered to the right and left.

At this period, von Kluck was under the orders of von Bülow, G.O.C. II Army; the subordination of one Army Commander to another produced unfortunate results. On the other hand, the III Army received its *directives* from the German G.H.Q.; but since the G.H.Q. was located at a considerable distance in rear of the battle front, it was not possible for it to keep in touch with the rapidly changing events where troops were in contact. In order to bring off the encircling movement planned by the Great General Staff with success, it was essential for the Germans to have arranged for unity of command in respect of the three Armies to whom had been assigned this important task. It was necessary that the movements of these Armies should be regulated with that *Gründlichkeit* for which Germany was renowned and of which

she made a boast. Instead, von Bülow attacked on the 21st August, a date too early to suit the arrangements of von Hausen and before the Saxons were ready. The earliest date by which the III Army could be ready was the 23rd *idem*; the XII A.C. which was to replace the XI A.C. was too far in rear to admit of its being employed effectively earlier than on the date last mentioned. Moreover, at this time the III Army could have been more advantageously employed in the region of Givet, and to that locality it should have been sent instead of being held on a narrow front at Dinant. The Great General Staff was really responsible for this failure in the co-ordination of the German effort on the Western Front.

The German II Army realised that it could not successfully cope single-handed with the situation on the Sambre. It was expected that von Hausen would lend support by advancing his right wing towards Mettet; at the same time the III Army was wanted in the South. The German Staff hesitated, orders and counter-orders were issued, and this resulted in producing confusion.

When von Hausen did finally attack on the 23rd *idem* on the Meuse, it was the magnificent defence of the French which took the Germans by surprise. In spite of the cannonade of the 57 German batteries aligned on the front Yvoir-Blaimont, in spite of the mass attacks of the Saxon infantry, the French held on to their positions until the evening of the date last mentioned and only retired when so ordered to do. This stubborn resistance upset General Baumgarten's plans. In his report to the German G.H.Q. the Commander of the III Army attributes the delay which took place in crossing the Meuse, and then only by weak detachments of his Army, to the difficulties of the *terrain* and to the presence of a *great body of franc-tireurs*!

However, the real defence of the Saxons contained in General Baumgarten's volume rests on grounds other than those mentioned above; grounds which are more substantial and supported by more convincing arguments. Thus at 4 a.m. on the 24th *idem*, when von Hausen wished to continue his march in a S.W. direction, having persuaded himself that von Bülow was in a position to deal unaided with the French 5th Army, a *liaison* officer of the II Army arrived on the scene and stated that on the previous day 5 French A.C. had been engaged and that whilst, on the whole, the German attack had progressed favourably, nevertheless it was absolutely necessary for the III Army to co-operate in an E. to W. direction during the continuance of the offensive ordered for the 24th *idem*. Von Hausen once more renounced the intention of marching S. and issued counter-orders. But Lanrezac was already in retreat on the evening of the 23rd *idem*. Another change in German plans took place at 9.45 a.m. on the 24th *idem*. The II Army had at last correctly appreciated the situation: von Hausen had now a free hand and began to march to the S., his right wing being directed on Mariemburg and his left on Revin-Rocroi. However, he was too late. The skilfulness with which Lanrezac directed his retreat, which was well timed; the splendid handling of the French 1st A.C. and the tenacious fight put up up by the 51st Reserve Division helped to ward off the pressing danger.

General Baumgarten expresses the opinion that the Germans would, to a certainty, have succeeded had weak detachments been sent towards Dinant; had the III Army been directed on Givet-Rocroi on the 20th *idem*; and had a strong cavalry force been employed to close the gap S. of Maubeuge on or about the 25th *idem*. He attributes blame for the German check on the German Higher Command.

Colonel Poudret points out that there is, however, one mistake in respect of which the blame cannot fall on the German Higher Command, namely that connected with the despatch on the 23rd *idem*, in all haste, of an improvised Division on Givet to which the task was assigned of pursuing the enemy along the left bank of the Meuse. This Division was sent off *without bridging equipment*; it came into contact with the enemy on the same evening, near Willerzie and met with obstinate resistance. As might well have been expected, this Division found the bridge at Fumay destroyed; it implored the IV Army to assist it with the loan of bridging material, but was not able to obtain the same. The Division next sought to cross the river at Revin, but here also the bridge had been destroyed. It was not till the 26th *idem* that this Division crossed the river, and it was only on the 27th *idem* that it was able to rejoin its A.C. (the XIX), after three days of useless marches and engagements.

The Saxon Army continued during the whole of the interval between the Battle of Mons and the Battle of the Marne to play its thankless rôle, first assisting one of the neighbouring Armies and then the other. Colonel Poudret describes the perplexing nature of the demands made upon von Hausen. Finally, on the 28th August, in view of the general situation, the German Armies were formed on a front which caused their further advance definitely to take a S.W. direction. Paris was included in the zone of action assigned to the German I Army, whilst the II Army was echelloned further to the W. The dispositions of the French Armies and their retreat caused the German Armies to advance more directly to the S.; the German right Wing was drawn to the E. of Paris, owing to the precipitate action of von Kluck, who, failing to appreciate the dangers lurking on his right, resolved to reach the Seine, at all costs, at the same time as von Bülow. That is to say, von Kluck abandoned the direction and the sector assigned to his Army. The want of firmness of the German Higher Command during these decisive days is striking. Moltke saw his orders flouted by the Army Commanders, who acted too hastily and assumed too much independence.

In the orders issued on the 28th August by the German G.H.Q., the VI and VII Armies were directed in the first place to oppose a French advance into Lorraine and Upper Alsace. On the other hand, should the French retire the VI Army (and the 3rd Cavalry Corps) was under orders to cross the Moselle between Toul and Epinal and march on Neuchateau: this Army constituted the left flank guard of the German Armies. The VII Army was to remain in subordination to the G.O.C. VI Army, until the latter Army had crossed the river, when it was to take on the independent mission of opposing the French should they advance between Epinal and the Swiss frontier. The Germans did not, it will be seen, renounce the operations planned for their left wing, in spite of the loss of the battle for the Charmes Gap, which had just ended. To

this retention of troops in this region must to some extent be attributed the reverse which the Germans met with on the Marne.

The III Army continued to be distracted by contradictory orders. On the 29th *idem*, not only was the IV Army appealing to it for help, but also the II Army—von Bülow was at the time fighting the Battle of Guise. On this occasion, von Hausen turned a deaf ear to these calls for assistance and stood by the Duke of Wurtemberg's Army. The Saxon Army continued to be faced with difficulties of various kinds up to the Battle of the Marne, and even during this Battle. The German G.H.Q. did not intervene once to help the III Army in the predicament in which it was thus placed ; it did not even fix any line of demarcation between the III and IV Armies, and, in consequence, much friction occurred. Again, in the orders issued, the task of capturing Hirson was assigned to the III Army, but when it arrived there the fort was already in the hands of the II Army : von Hausen had received no intimation in the change of plans.

The orders issued by the German G.H.Q. continued to be faulty up to the eve of the Battle of the Marne. On the 3rd September, the I and II Armies were duly informed of the intentions of the Great General Staff, but the III Army was left entirely in the dark.

The Germans however changed their plans. Having learnt that in their retirement the French had left Paris somewhat at a distance on their left, the question arose of cutting the French off from their Capital and rolling them back in a S.E. direction. The Germans seemed to have been blind to the menace of Paris and of Maunoury's Army ; von Kluck thought only to ensure the arrival of his Army on the Seine according to his own plans and advanced towards the river by forced marches. The situation thus became one in which the Great General Staff exercised less and less control. The orders issued on the 5th September indicate that the Great General Staff had lost touch with the situation : these orders are quoted in the original text :—

" His Majesty orders :

" The I and II Armies to remain facing Paris on the E. ready to act " offensively against any enemy forces which may issue from the " fortress. 1. The I Army is assigned to the sector between the *Oise and* " *Marne* ; the II Army to the sector between the Marne and Seine. The " 2nd Cavalry Corps to act with the I Army and the 1st Cavalry Corps " with the II Army ; 2. The III Army to advance on Troyes-Vendeuvres; " 3. The IV and V Armies to open a passage on the Upper Moselle for " the VI and VII Armies by advancing, without a halt, in a S.E. direc- " tion ; the Right wing of the IV Army by Vitry, and the right wing " of the V Army by Revigny. The 4th Cavalry Corps to reconnoitre " in front of the IV and V Armies ; 4. The missions of the VI and VII " Armies to remain unchanged."

Thus, whilst von Kluck was already on the evening of the 5th September on the Grand Morin, his Army was assigned to the sector between the Oise and Marne ! This shows clearly enough how completely the German Higher Command had lost touch with the actual situation.

The Battle of the Marne had scarcely begun before von Hausen found himself being appealed to for assistance and even for advice. In con-

sequence, the III Army was strung out on too extended a front, its right wing was fighting with the Guards Corps under von Bulow, its left wing, the XIX A.C., with the right wing of the Duke of Wurtemberg's Army (the VIII A.C.). It was as much as von Hausen could do to close the gaps caused by the badly co-ordinated plans of the German Commanders: he could in no way take advantage of the situation created by the gap in the French line between Sompuis and la Maurienne, opposite his front.

Colonel Poudret shows how it was that the Saxon Army became dispersed soon after the great Battle on the Marne began.

During the titanic struggle, which continued for five long days, the III Army had made considerable progress: just before the German retreat began, its right had passed beyond la Maurienne, its centre was S. of Mailly, whilst its left wing was held up on the line Sompuis-Huiron.

At this time, General Foch's position appeared to be seriously compromised, not that he was willing so to admit: his optimism, as events turned out, was fully justified. Since the early morning of the 9th September sinister rumours had been reaching the H.Q. of the III Army: at 7.45 a.m. a wireless message was received from an unknown source, probably German G.H.Q., indicating that things were far from going well. The message stated that the II Army had withdrawn its right wing to Marigny: at 1 p.m. a further message arrived showing the seriousness of the situation. The last message ran as follows: "The II Army in retreat, right wing Damery."

The game was lost. Von Hausen nevertheless was able to report: "We have taken Euvy." However, at 2.15 p.m. the Staff of the III Army found it necessary to issue orders for a retreat and to make preparations for recrossing the Marne. At 5.30 p.m. further confirmation was received concerning von Bülow's retreat and also of the fact that the I Army too was retiring. As it was during the Battle of the Marne, so in the retreat from that river, the III Army was separated into two groups: the XIX A.C. continued to co-operate with the IV Army, whilst the XII A.C. acted practically under the orders of the G.O.C. II Army.

If from a tactical point of view, the German retreat was conducted in good order, it was not so from a strategical point of view. The German Higher Command did not at all times have a grip on the situation. The III Army received orders for the 10th September directing it to be ready to resume the offensive to the S. of Chalons; had it been so employed it ran the danger of being isolated S. of the Marne, for the II Army was retiring. The latter Army called to the III Army for help, but von Hausen seems to have had enough of this sort of thing and replied: "Please do not uncover the flank of the III Army."

The III Army again had to choose between the "directives" of the Higher Command and von Bülow's cries for assistance: it did not know what to do. Von Hausen decided to remain S. of the Marne and called on von Bülow to allow the rear-guard of the Guards Corps to cover his threatened flank. However, von Hausen was not long able to maintain his Army in this region single handed. Fortunately, an order arrived at 5 p.m. from the German G.H.Q., instructing von Hausen to conform to the movements of the II Army, then retreating on to the line

Mourmelon-le-Petit—Francheville, to dig in there and hold on. The retreat of the Saxon Army from the S. of the Marne was carried out during the night of the 10/11 September and on the 11th *idem*. Von Hausen left Chalons at 4 a.m. on the last-mentioned date for Suippes, where von Moltke was awaiting him. The presence of the Chief of the Great General Staff did not put a stop to the issue of counter-orders. The Saxons had scarcely begun to throw up entrenchments on the line indicated to them, when the plans were once more changed. Von Moltke had, in going to Suippes, passed the II Army and this resulted in the orders to the III Army being modified: it was now ordered to dig in on the line Thuizy-Suippes.

On the 12th September, von Bülow retired his left wing and invited von Hausen to carry his front to the N. of the line Prosne-Auberive-Souain. The Saxon Army Commander refused to do so, but at 7 p.m. an officer from the German G.H.Q. arrived on the scene and insisted upon von Bülow's request being complied with: this order was carried out. On the 13th September, von Hausen gave up his Command and was replaced by von Einem.

During this first phase of the Great War, thanks to the weakness of the German Higher Command, the Saxons had had to play a thankless rôle and had been unable to show what they were capable of. Colonel Poudret is of opinion that, to some extent, von Hausen was to blame for the state of affairs which prevailed: had he acted with greater firmness, he might have prevented the continual splitting up of his Army. He ought, it is said, to have also limited the initiative of his subordinate Commanders. Had he done so he might have been in a position to operate effectively against the right flank of Foch's Army opposite the Mailly Gap.

W. A. J. O'MEARA.

RIVISTA DI ARTIGLIERIA E GENIO.

Nov.—Dec. 1919.

THE SINKING OF THE "VIRIBUS UNITIS."

The authors of the last tragedy of the Austrian marine were two Italian Officers, Major of Naval Engineers Rosetti and Medical Sub-lieutenant Paolucci. Independently one of the other they had proposed to penetrate alone into the port of Pola and to reach one of the enemy's ships at its anchorage. Rosetti had been at work for a long time preparing a special machine for the expedition. The young Medical Officer had invented no machine, but proposed to swim, pushing a kind of mine before him, and anticipated a long immersion at night in the cold water of the lagoon.

Rosetti's apparatus consisted of a type of torpedo with two detachable mines in the front part, each containing about 160 kg. of trotyl. In the back part there was a motor worked by compressed air, which was

stored at high pressure in a tank, with capacity sufficient to drive the mechanism for some hours at a slow speed. The mines could be readily fixed at any required depth to the bottom of a ship and a clock mechanism regulated the moment of explosion. The apparatus could carry two men, who rode astride on it and guided it with their hands in the water. It was decided that the two officers should work together, and after two months of hard labour, during which they learnt to overcome obstacles of every kind, they were ready for their hazardous adventure.

At 10.0 p.m. on 31st October, 1918, Rossetti and Paolucci descended from a M.A.S. which brought them within 400 metres of the outer defences of Pola. They were clothed in light water proof clothing, which covered their heads, leaving only their eyes free, and was fitted with air chambers on back and breast, and coated with a preparation of camphor to increase its resistance to the water.

Between 10.30 p.m. and 3.0 a.m. after great efforts the two officers succeeded in passing the outer defences and two strong and complicated interior booms. They passed close to the guard battleships and the sentries without being seen, driving their machine against the tide and helping themselves forward with their hands. Finally they came to the dark masses of the enemy's ships of the line, and with their tank nearly exhausted they pushed forward to the far end of the line deciding to attach their mines to the Admiral's ship. They had to go very slowly lest the phosphorescence of the water disturbed by their little screw should attract the notice of a sentry.

A little before 5.0 a.m. they found themselves less than 40 metres from the *Viribus Unitis*. Rossetti detached one of the mines and fixed it to the side of the ship. This took about half-an-hour, and meanwhile Paolucci waited at a little distance, doing his best to prevent the apparatus from striking against other ships. At 5.30, as dawn was breaking, Rossetti rejoined his companion, having adjusted his mine to explode at 6.30.

Just then the alarm was sounded and the two officers were seen from the doomed ship. Hastily opening the immersion valves of their torpedo and setting the mechanism of the second mine, they started the motor and jumped into the water and were captured. The second torpedo exploded against the great transatlantic steamer Wein, which subsequently sank.

Brought before the commander of the Admiral's ship the officers were informed that the fleet belonged to the Jugo-Slavs, as the Austrian Admiral had disembarked a few hours previously and all the crew who were not Jugo-Slavs had also left the ship. " If that is so " said Rossetti " I have to inform you that the *Viribus* will be blown into the air, and it is best to send away the men immediately."

These words spoken with much seriousness convinced the Commander Vukovitch, who gave orders to abandon the ship, allowing the two Italian Officers to be placed in safety. They tried to escape by leaping into the water, but were quickly recaptured by a number of excited sailors, who wanted to imprison them in the lower parts of the ship. While this was being discussed, at 6.30, a violent explosion shook the

battle-ship. The sailors fled and Rossetti and Paolucci were able to leave the *Viribus Unitis* for the second and last time. She began to sink and a few moments later capsized. The commander Vukovitch met his death bravely at his post, his skull fractured by a great beam as the ship sank.

The two officers remained prisoners-of-war for a few days, when to their joy they saw Italian war ships entering the port.

Had the war continued other plans were in course of preparation to strike another serious blow against the Austrian battle squadron. But the enemy's army, which only four months before had been promised the free sacking of the plains of the Piave, was dispersed beyond the Alps, suffering terrible losses.

E.T.T.

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