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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.

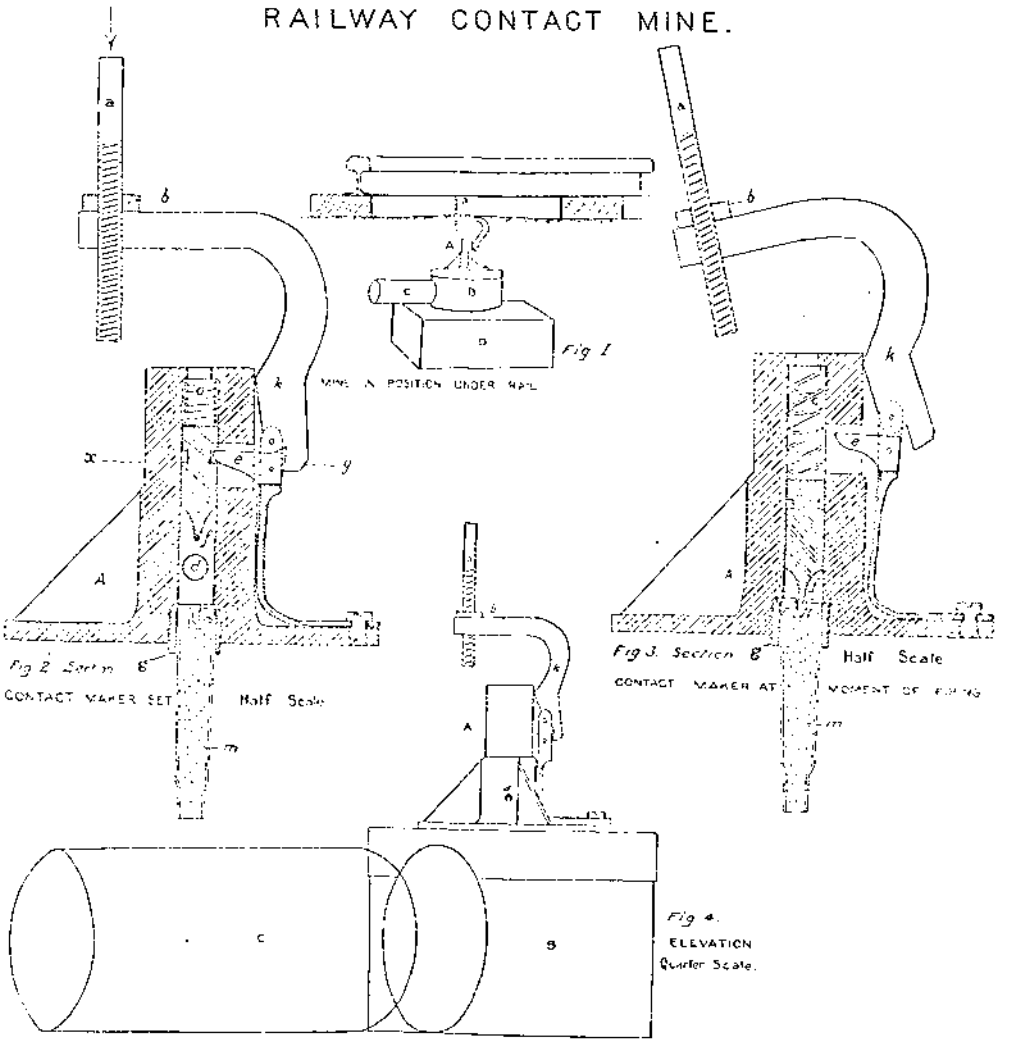
2. The Prize shall consist of (*a*) a book on Survey, Exploration, Travel, Geography, Topography, or Astronomy; the book to be whole-bound in leather, and to have the Montgomerie book-plate with inscription inside; (*b*) the remainder of the year's income of the Fund in cash.

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.

RAILWAY CONTACT MINE.



DETAILED DESCRIPTION.

A. The Contact Maker.
B. Cylinder of about 5lbs. dynamite in solid mass.
C. Cylinder of mixed explosives, about 5lbs.
D. Additional number of dynamite cartridges—usually about 20lbs. in a wooden box.

The Contact Maker (*A*), *Fig.* 2, consists of a brass casting some 3¾" high, bored axially to contain a spring (*c*) and a striker (*f*), much like those of a rifle. When the spring is compressed, the striker is retained in its "set" position by a metal stop (*e*). This stop is connected with the spring release (*k*), which is fitted with the adjustable pointer (*a*) at the upper end. The construction of the spring release is such that, when a vertical pressure is applied to the upper end of the pointer (*a*) (in the direction of the arrow), the stop (*e*) is withdrawn and the striker is released (*Fig.* 3). At the lower end of the vertical channel, in which this striker runs, is attached the screwed socket (*g*) which retains a cartridge (*m*) ('303 or '450) with its base against the lower end of the said channel. Consequently, when the striker is released (as explained above) its point will strike the cap of this cartridge. This cartridge contains dynamite. Safety in manipulation of this Contact Maker is ensured by a safety pin, which crosses the striker channel at right angles by means of the two opposite holes (*d*), thus intervening between the striker point and cartridge cap.

The base of the Contact Maker stands on the top of a tin cylinder, filled solid with broken up dynamite. The cartridge (*g*), which projects below the base, is inserted into a prepared hole in the centre of the top of this cylinder, and communicates its explosion to the mass of dynamite within.

There is usually a second cylinder of mixed explosives (C) –guncotton, nitro-powder, dynamite, etc.—introduced into the cylinder (B) through a hole in its side, and detonated by its explosion. The object of this cylinder (C) is not very obvious (none of the explosives used being any more powerful than dynamite), unless it is used to economise the latter.

The cylinder (B) may also have an additional box of dynamite (D) beneath it, containing perhaps 150 sticks (20 lbs.).

RAILWAY DEMOLITIONS AND REPAIRS.

By CAPTAIN H. L. WOODHOUSE, M.C., R.E.

IN *R.E. Journal* January 1919 there are some notes on demolitions carried out on the Hedjaz railway. The Indian Railway Sappers and Miners had considerable experience both in East Africa, and later in Palestine, of repairing demolitions, and the following notes give some idea of the interruption to traffic caused by the various types of demolition.

Though the two countries differ in almost every respect in that in Africa the line usually runs through thick roadless bush, in which animals cannot live and motors can only move along a few tracks, still, so far as the railways themselves are concerned, they are much alike, being lightly built narrow gauge lines intended for light traffic, and lacking the repair shops and complete equipment of a standard European line.

Railway demolitions fall into two quite distinct categories. There are the hasty demolitions carried out by raiding parties, in which the time for work is usually limited; and the more deliberate destruction of a line to deny its use to an enemy when an army is retiring. Both types had to be dealt with in East Africa.

Blowing up a rail by itself is hardly worth the trouble, unless a large number are done together, and the enemy is short of permanent way material. If this is done, the method of laying guncotton under a joint gives the best result. It is very difficult to straighten a vertical bend; particularly if it comes so near the end of the rail that, when the screw of a jim-crow is placed where the bend begins, one of the claws comes beyond the end of the rail—that is when the bent portion is less than twelve inches from the end of the rail. There was only one case in East Africa of a charge being placed under the middle of the sleeper as was done on the Hedjaz railway. Then the sleeper was wooden. Beyond shattering the sleeper no damage was done. On the Voi-Maktau military railway this sort of attack was an annoyance, as the grades were so steep (4% in places), the curves so sharp (14 degrees), and the bush through which it ran so thick, that after such an explosion was heard trains had to crawl till the line had been patrolled. Otherwise they could not stop in time to avoid a derailment. The sound was no guide to the position of the explosion, owing to the way it was affected by the hills through which the line ran; but at first the enemy kindly gave

the necessary information by cutting the telegraph wires at the same time as the line. Almost as much delay was caused several times by explosions in the bush, as the line had to be patrolled to make sure it was intact. Whether these explosions were caused by raiding parties of African troops who found the line difficult to approach, and exploded their dynamite in the bush to give audible proofs of their action to their main body, or whether they were due to other causes, was never ascertained.

Considerable results can be obtained either by exploding a mine under a train, or by loosening a rail and thereby derailing the next train. In both cases it is the derailment, not the damage to the track, that gives the trouble. If this can be arranged to take place where a diversion is impossible, as for instance in a deep cutting or where the line runs along a steep hillside, so much the better. The former is better, as in an emergency trucks can easily be thrown down a bank to clear a line, though engines are usually too precious to be treated this way.

At first the enemy in Africa used observation mines, but after an incident when a whole train jumped a gap 2ft 7in long which he had blown out of the rail, and the raiders had lost their exploder in their hasty retreat, he used contact mines with considerable success. The charge was about 50 lbs. dynamite and the firing apparatus is shown in the diagram.*

The apparatus was buried in the earth of the permanent way, the top end of the pointer (*a*) alone projecting. This end made contact with the under side of a rail, with the help of the adjustable back-nut (*b*). On passage of a heavy vehicle the rail sank slightly, depressing the pointer and firing the mine.

The damage done to the engines by these contact mines was a serious matter, as at that time engines were none too plentiful. To save them, one or two sand trucks were run in front of all trains to take the brunt of the explosion. As this reduced the capacity of the trains, loaded waggons soon replaced the sand trucks. On one occasion when a mine exploded the damaged waggon was unfortunately loaded with whisky. An apparatus was captured intended to reply to the sand truck arrangement. It was much the same as the ordinary exploder, but had a ratchet in addition, which, working by the depression of the rail as each wheel passed, finally withdrew a safety pin after a given number of wheels had passed. It was ingenious, but did not work in practice.*

These mines were generally laid by night. The raiding parties

* Specimens of these two types of contact mines, and also of a third, a modification of the first, intended to catch patrolling trolleys, have been presented to the R.E. Museum by Lt.-Col. R. L. McClintock, C.M.G., D.S.O., Superintendent of Park, 2nd (Q.V.O.) S. and M., to whom the Institute is also indebted for the attached diagram. (ED. *R.E.J.*).

had to make their way across a waterless desert, in some places 80 miles wide, and preferred to have a good start of any pursuit. By day the line was watched from small sentry posts at the end of, or in the middle of, each straight. Any suspicious party on the line could be easily seen. The defence was more difficult at night, and was finally solved by sending out groups of six men at dusk who established posts about a mile apart and kept two men on continuous patrol along the line. This ensured that no part of the line was left unvisited for more than half an hour. Experiment showed that it took about forty five minutes to bury a mine. Once planted nothing but a thin rod, which was very difficult to detect, showed above the earth ballast. In the early days when the ballast almost touched the rail throughout, detection was very rare; but afterwards the ballast was sloped away from the centre of the track, and a gap of two or three inches was left between the rail and ballast. Even so, when mines in place were spotted it was generally due to the disturbance of the surface. One hundred rupees reward was offered for every mine discovered. In addition to the men watching on the line, patrols of intelligence scouts, operating on the tracks leading from enemy territory, were useful in giving warning of the presence of raiders in the neighbourhood.

The enemy protected his line in much the same way. But its comparative immunity from attack was chiefly due to the help given by the natives living in the range of hills immediately north-east of the railway; who, being under the influence of the missionaries there, stopped our parties.

The most successful instance of tampering with the track occurred on the German Central railway. A party of South African cavalry loosened an outer rail on a curve, where the line ran on a high bank on a steep down grade through the usual thick bush. The train conveying the German rearguard, retreating down the line before our main body, was completely wrecked.

Bridges were only damaged on two or three occasions. In one case there was no guard, on another the enemy approaching to very close range under cover of the thick bush surprised the guard. The small parties which occupied blockhouses on either abutment, joined by a continuous belt of barbed wire, were too much for small parties to tackle.

The raiders were never strong enough to adopt the method of turning over the track complete. In Palestine, after the armistice, a track had to be replaced which had been disconnected at every second joint and turned over. Almost every length had to be pulled backward or forward for a few inches to bring the ends of the rails together. Before fast running could be allowed the whole length had to be packed again.

After the invasion of German East Africa began, the problem of

repairing the enemy lines arose. The track had been dismantled at intervals for the first thirty miles of the Northern railway, and the points and crossings blown up. At first the fishplates and bolts, the bearing plates and clips had been removed and hidden; later the nuts had been knocked off the clip bolts with a heavy hammer, and only the fishplates and bolts removed. The rails, and sometimes the sleepers, were thrown down the banks or into the ditch. Some of the small stores were thrown into rivers and were irrecoverable; in other cases they had been buried. Most of the latter were recovered from information given by natives, or more frequently from the grass and branches, used to camouflage the newly turned earth, withering and showing up conspicuously in the jungle. The search for this material took time, and finally it was found to be quicker to relay with British material. The shortage of clip bolts was not very important as, if four out of the eleven sleepers per rail were clipped on the straight, slow traffic could run. The fishplates were much more trouble, especially on curves. Various improvisations were tried, such as fixing the rail ends to wooden blocks with coach-screws, but they were not satisfactory.

No damage had been done to the track on the Central railway. This was a mistake, as the bridges were quickly repaired well enough to pass motor lorries mounted on railway wheels, and the parties carrying out heavier repairs to enable engines to be used were able to move up the line with their tools and stores on hand trollies. These could be hauled across the gaps even before the light repairs were done. Thus a large number of bridges were under repair simultaneously. When it is remembered that animal transport was impossible, and roads fit for motors few and far between, the advantage of having even hand trolly transport available will be realised.

Attempts had been made to destroy most of the bridges. Some five metre reinforced concrete culverts had suffered no damage from the explosions, and generally small stone arches had not suffered as much as steel bridges. Dynamite was the explosive used, and judging by the number of unexploded cartridges found among the debris, it must have deteriorated in the bad climate. Abutments were attacked by removing the squared face stones in three or four places, and hollowing out chambers in the softer rubble backing. Plate girders had both flanges and the web cut at one end. Trusses had both top and bottom booms cut. In many cases rolling stock had been run into the gap; and in one case an engine was put on a bridge before it was brought down. Where rivers were crossed rolling stock and old iron of every description were thrown in above and below the wreck.

Repair methods varied. Rail girders were largely used. The rule of thumb which allows one rail, of the same dimension as the running rail, per foot of span under each running rail is amply safe

up to fifteen feet span, and gives a large margin for spans of less than twelve feet. Two girders each of four 85 lb rails carried small metre gauge engines safely over a 17 ft span. (The running rail was about 45 lbs.). Rail girders, laid under the track sleeper, strengthened stone arches when the explosion had brought down some of the rings without disturbing the formation. Supports were either trestles or crib piers. Iron sleeper cribs filled with stone ballast or rubble stood for a time; but they could not be relied on for long as the sleepers gradually flattened out.

Where diversions were impracticable rolling stock thrown into the gap increased the time required for repairs as clearing had to be done to find foundations for the cribs or trestles. On the other hand, in some cases, the girders, though cut, were held in place by the track. This considerably reduced the time taken in repair as cribs could be erected at once right up to the girder, and the latter jacked up level. Some captured 20 ton differential blocks proved very useful for lifting girders, and a jack fitted with hooks at each end was very useful for horizontal adjustment.

The most inefficient demolition met with was that of a 50-metre truss crossing a stream. One abutment had had about 2 feet blown off it, but the girder was intact. It was raised on cribs by means of large jacks and traffic passed before dark, though the repair party only arrived about one o'clock.

In one or two instances the line had been blocked by running two trains into one another. When the site of the collision is well chosen this is an excellent method. An excellent chance was missed, when five trains were found slightly damaged, in a siding four miles away from a cutting forty feet deep and half a mile long. With the tools available, it would have taken several days to clear these trains if they had been piled up in the cutting.

From a repair point of view this is one of the most awkward demolitions. Big steam cranes are not plentiful on most lines, and they are awkward things to bring up over hastily repaired track and bridges. Big bridges generally mean diversions. In one instance on the Central railway a string of awkward demolitions was cut out by making use of five miles of an old formation which had been abandoned. It was not by any means a perfect line, but its use enabled trains to be got through a good deal sooner than the other bridges could have been repaired. Consequently the first thing to look for when choosing a site for a demolition is the possibility or otherwise of a diversion. It is more important to cut the girders than to bring down the piers of a large bridge, though both should be done if there is time; trestles or cribs can be easily made, big trusses cannot. On the other hand it is essential to damage the abutment of a small bridge, otherwise the enemy can easily cross on a rail girder. Thirty 10-metre rails and a crib or small trestle will

take a train comfortably over a thirty foot gap, and takes very little time to erect. A waggon or two pushed over the edge after the bridge has been brought down will add appreciably to the difficulty of repair.

When a bridge has been knocked about by shell fire it is well to remember that bridges generally have a factor of safety of 6 and an additional allowance for impact, which brings it up to about 10, so that trains can crawl over, after some of the members have been considerably reduced in cross section. Even if engines cannot pass, four wheeled waggons, whose axle load probably does not exceed half that of the engines, may be hauled over with a long rope.

The standard type of water tower on the German lines was a steel hemispherical tank on a lattice staging. The legs of these had been cut and the tank was usually badly damaged by the fall. In one instance where the tank was undamaged and the legs had been cut at ground level, repairs were easily made by hoisting the tank and legs upright again with a derrick, and embedding the feet in masonry. If the legs had been cut half way up, the job would have been more difficult. Usually iron tanks on sleeper cribs were erected as a temporary measure.

It sometimes happens that the source of a water supply is some way from the station. One such source was attacked and blown up which was five miles from the station. As it was only a system of filter tanks on the bank of a mountain stream, the repair was not such a serious matter as if it had been a pumping station.

The telegraph signal instruments had all been removed or destroyed by the enemy. They were replaced by telephones.

THE BATTLE OF THE SOMME.

THE 33RD DIVISIONAL ENGINEERS AND PIONEERS AT HIGH WOOD, 15TH TO 22ND JULY, 1916.

[*From the report of the* C.R.E., 33RD DIVISION.]

1st Day, 15th July. (1) The 11th and 212th Field Companies R.E. reached the south-east corner of Mametz Wood with the 19th and 98th Infantry Brigades on the morning of the 15th, and stood by ready to move at fifteen minutes' notice, their transport being engaged in pushing up R.E. material to Bazentin-le-Petit Wood, ready to put it into work forthwith.

(2) The 222nd Field Company advanced with the 100th Infantry Brigade on the night of the 14th to consolidate the Switch Trench in High Wood after it had been taken. The capture of this trench having failed owing to uncut wire and heavy machine-gun fire, the Officer Commanding the Company, in consultation with the senior Officer on the ground, dug and wired a support point in the centre of the valley midway between High Wood and Bazentin-le-Grand, returning in the evening to bivouac south of Mametz Wood.

(3) The 18th Middlesex Regt. (Pioneers) was detailed to repair the roads and trolly line leading to Bazentin-le-Petit Wood. It left its bivouac at Bécordel at 8.45 a.m., returning at 6.45 p.m., having carried out surface repairs over a considerable length of the road. The Pioneer transport was engaged in pushing forward R.E. material to Bazentin-le-Petit Wood.

2nd day, 16th July. (1) Consequent on the withdrawal of our troops from in front of the Switch Trench and High Wood to a line in front of Bazentin-le-Petit, two sections of the 11th Fd. Company worked during the night of 15th—16th in making a strong point of the Cemetery and wiring it round. Another section made two platforms for observers in the mill situate on the line held east of the village. The 4th Section made a signal dug-out for Headquarters 19th I.B.

(2) One Section, 212th Fd. Company, and two sections 222nd Fd. Company worked during the night 15th—16th in constructing a strong point at the north end of Bazentin-le-Petit village, and another section of 212th fortified the ruined church in the centre of the village as a keep. The two remaining sections of 212th worked by day on clearing the road through the village. The two remaining sections of 222nd were kept in reserve, collecting material for repairing the trolly line and constructing dugouts for Brigade Headquarters.

(3) The Pioneers continued road and trolly line repairs. Constant heavy traffic caused them much delay. The crossing over the German 2nd Line trenches was completed fit for heavy artillery, and the road leading down from Mametz Wood was repaired and widened. The Pioneers moved bivouac from Bécordet to Fricourt Wood.

(4) The transport of all units was engaged in pushing R.E. material to the forward dump.

3rd day, 17th July. (1) The 11th Fd. Company completed the strong point at the Cemetery, one section remaining in reserve and constructing dug-outs at Brigade Headquarter bivouac.

(2) The 212th Fd. Company worked on strong points at the north and east of Bazentin-le-Petit village, and on the church, and clearing roads through the village.

(3) The 222nd Fd. Company repaired the trolly line between Mametz and Bazentin-le-Petit Woods.

(4) No R.E. material could be got beyond Mametz Wood owing to heavy and constant shelling between Mametz and Bazentin-le-Grand Woods.

(5) Heavy rain had made the road surfaces in a very bad state. Vehicles were constantly sticking fast and blocking the roads. The congestion of traffic resulting from this was very great and the Pioneers had consequently to continue road repairs. The worst places were corduroyed with timber, and much brick from ruined buildings was transported and laid in other portions of the road.

4th day, July 18th, (1) During the day one section of the 11th Fd. Company worked on a strong point on the east side of Bazentin-le-Petit village from which the ground along the whole eastern side of the village could be enfiladed. Fire-stepped trenches and a machine-gun emplacement were constructed in spite of a heavy bombardment. During the night 18th—19th, one section helped the Royal Welch Fusiliers in making two small posts about sixty yards north of the village, and the remaining section—this company having been reduced by casualties to three sections—continued the work done during the day on the strong point on the east side.

(2) The 212th Fd. Company took over in the morning from the 97th Fd. Company of the 21st Division the works in hand in Bazentin-le-Petit Wood. Further work on these was interrupted by heavy bombardment of the wood all the afternoon.

(3) The 222nd Fd. Company continued repairs to the trolly line into Bazentin-le-Petit, and constructed new trolly frames for wheels taken from German trucks. They also brought up fifteen truck-loads of R.E. material through Mametz Wood for use on strong points in Bazentin-le-Petit Wood.

(4) The Pioneers continued repairs to road surfaces, and the

transport of all units brought up R.E. material to the forward dumps.

5th day, 19th July. (1). The 11th Fd. Company returned in the morning from work at Bazentin-le-Petit village to their bivouac at the south-east end of Mametz Wood. The Company, less one officer and 11 O.R., left its bivouac again at 12 midnight to join the Infantry detailed for the assault on High Wood.

(2) The 212th Fd. Company left its bivouac at the south end of Mametz Wood at 8 a.m. for work on the strong points in Bazentin-le-Petit village and wood. Good progress was made on these works. After returning at 5 p.m., two sections went out again to the village and wired under heavy fire, after 200 man-loads of R.E. material had been brought up to the north of the village.

(3) The 222nd Fd. Company continued repairing the trolly line and constructing trollies.

(4) The Pioneers continued road repairs.

6th day, 20th July. (1). The 11th Fd. Company joined the 20th Royal Fusiliers north of Bazentin-le-Grand at 2.30 a.m. The company was to advance into High Wood as soon as it was taken and construct certain strong points decided upon beforehand. Each section carried tools and stores, and a Company of Pioneers was detailed to assist. Subsequently, owing to the situation in the wood, the Pioneer Company was diverted to communication trench excavation. One section of the 11th Fd. Company dug in at the rear end of the wood, pending orders from the officer commanding, Captain Sim, who went into the wood to reconnoitre. Under the heavy shell-fire the officer in charge of the section and the N.C.O. were wounded. A lance-corporal remained in charge of the section. At 9.0 a.m. Captain Sim and the lance-corporal were also wounded, there being then only eleven men left of the section. These joined one of the other two sections. Another section moved up to a small trench on the south-west face of the wood and waited in it for the enemy at the north end of the wood to be pushed out, to enable them to get to the tasks allotted them. As at 11 a.m. the enemy with a machine-gun were still in the north of the wood, they proceeded to construct a fire trench projecting out from the west face to enfilade the west corner of the wood, and this was done without help from the Infantry. During the afternoon the enemy was pushed out of the wood to the extreme north corner by the Royal Welch Fusiliers. The digging of a trench was then taken up with the Infantry at 7.45 p.m., down a clearing about 100 yards from the north-west face of the wood. At 10.30 p.m. the portion of this trench was about four feet deep, and traversed, when the infantry fell back under a heavy counter-attack out of the trench which was vacated and lost. The remaining section of this company after entering the wood moved up the south-east face and commenced under heavy shell-fire a strong

point projecting out from the north-east face. The officer in charge was wounded and the sergeant killed. The section completed and wired the work under a corporal by 9.0 p.m, when the section was called on by an Infantry Officer to man the north-east face of the wood, where it dug itself in in rifle pits, and remained until ordered to retire to the support trench.

On receipt of information at Brigade Headquarters at about 9.30 a.m. that the O.C. of the Company was wounded, Captain Pressey, the next in command, at once proceeded to the wood with the 51 men left at the bivouac, and remained there throughout the day until 12.15 a.m. when firing having quieted down and reliefs having arrived he returned to bivouac.

(2) 3 Sections of the 212th Fd. Company left their bivouac at Mametz Wood at 7.30 p.m. under orders to relieve the 11th Fd. Company in High Wood. They reached High Wood at 9 p.m. Owing to the Infantry party detailed to carry up R.E. material for them having been diverted to other duties, and the Infantry in the wood having retired from the line the Company was ordered to consolidate during the night, no work was done.

(3) Two sections of the 222nd Fd. Company proceeded with the 11th to the point of assembly north of Bazentin-le-Grand. Definite tasks were allotted to them. They remained at the assembly point until the O.C. 11th Fd. Company sent word for them to come up. By then heavy barrage fire had been opened by the enemy, and in moving up the officer in charge was killed and a number of men wounded. The two other sections went out at 8 p.m. and dug a support point south of the road leading from Bazentin-le-Petit to High Wood.

(4) The Pioneers started work after the assault on High Wood excavating a communication trench to the wood. The enemy's heavy barrage fire caused considerable delay in the progress of this work.

7th day, 21st July. (1) The 11th Fd. Company remained in bivouac, having suffered heavy casualties and lost all their officers but one in High Wood.

(2) The 212th Fd. Company was throughout the day in High Wood, where they assisted in trench excavation and brought up 120 man-loads of R.E. material for use in consolidation. They withdrew at 7.30 p.m., the Division being under relief.

(3) The 222nd Fd. Company were employed through the day on the strong points started by the 7th Division in Bazentin-le-Grand. Two strong points at the cross roads north of the wood, and one east of the wood were completed, with machine-gun emplacements and wiring, and work was done on the keep in the centre of the village.

(4) The Pioneers continued work on the communication trench leading to High Wood.

The Division was relieved on the night 21st—22nd July.

Casualties.

	Officers.		Other Ranks.		
	K.	W.	K.	W.	M.
11th Fd. Company ...	0	4	11	53	3
212th ,, ...	0	2	1	19	0
222nd ,, ...	2	0	0	24	0
Total ...	2	6	12	96	3

HIGH SPEED WIRELESS INSTALLATION.

WHEN, probably in the not very distant future, it has become the normal practice to receive wireless messages much in the same way as ordinary line telegraph messages are nowadays received, that is in the form of paper strip inked in morse code or printed in Roman character, or when it has also become quite customary to transfer a wireless message automatically and immediately to land line instruments, and to perform these operations at the same speeds as those now possible in line telegraphy, it will be interesting to have it on record that some of the pioneer work in these directions has been carried out by officers of the Royal Engineers and other workers attached to them, impelled in this direction by the mass of wireless traffic imposed on the Signals of a modern army when open warfare is resorted to on a large scale, and line communication becomes difficult to instal.

For some time experiments in this direction have been in progress at the Signals Experimental Establishment on Woolwich Common, and it is now found to be quite practicable to handle traffic by wireless telegraphy at speeds of one hundred words per minute, using the standard Post Office type of Wheatstone transmitter with punched tape for transmission, and the standard Wheatstone inker for reception. It is also obvious that a message which can be made to operate an inker can also be employed to actuate a printer receiver of the Creed or other well-known type, or to operate a line transmitter and so translate the wireless message direct on to land lines.

The first practical tests of this method were carried out between Woolwich and Bedford in July 1919, when a speed of 62 words a minute was reached.

After other trials with gradually improved instruments a prolonged test was made between Woolwich and Weymouth using quite moderate power. The apparatus was not tried at much over one hundred words per minute, but perfect records were obtained at the following speeds:—2017 words in 30 minutes, 901 words in 8 minutes and 379 words in 4 minutes.

Those accustomed to handling wireless traffic will readily realise the value of being able thus to receive at speed on a standard inker, and will appreciate the value of this experimental work. It may be added that there would not appear to be very much difficulty from the electrical point of view in attaining very much higher speeds. The only limit is that set by the exigencies of mechanical design.

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

(Continued).

CHAPTER IV.

TEMPORARY BRIDGES.

(Reference MAP *following* PLATE XXIV., *page* 216, R.E.J. *November*, 1919)

Introduction.—General types of Bridges.—Pontoon and Trestle Equipment.—Haute Deule Canal.—Canal du Nord—Hasty Bridges constructed by one Corps.—Work of the R.E. of another Division in crossing the Canal du Nord.—The Escaut Canal and River.—Tank Crossings.—River Selle.—Tank Bridge over the River Selle.

1. INTRODUCTION.

During the final advance from August to November 1918, an enormous amount of hasty bridge work was thrown upon the Divisional Royal Engineer units.

Every successive stage of the enemy's retreat finished by his taking up a position behind a water obstacle after destroying all existing crossings. The forcing of a passage of the waterway would therefore always become the first stage of the succeeding battle.

In the course of these three months many hundreds,—probably thousands,—of light bridges for Infantry and First Line Transport were made by Divisional Troops, in addition to many crossings for Tanks and Heavy Artillery.

A full account of this work is manifestly impossible; all that will be attempted here is to give a description of some typical operations, and types of Bridges constructed.

The names of units and formations concerned are purposely omitted.

2. GENERAL TYPES OF BRIDGES.

Foot bridges of every variety were constructed, the type generally depending on material that happened to be most easily obtained at the moment.

Floating piers were made of cork, oil tins, captured German floats etc, in order to make hasty single file bridges for Infantry. *Plate* XX gives details of the usual type of cork pier, and *Plate* XXI a

petrol tin pier. The standard pontoon equipment was extensively used for passing over field guns, and first line transport.

On one river there were actually 30 pontoon bridges in position simultaneously on the front of one single British Army.

The cork floats were probably the most satisfactory of all for Infantry troops, as they were found to be absolutely impervious to shrapnel or splinters.

The supply of cork was never equal to the demand, and is an interesting example of the difficulty in foreseeing requirements. Cork floats had been experimented with before the advance and found sufficiently satisfactory to justify a considerable number being made up at the Base. Their use had been explained to all Armies, and Chief Engineers were asked in the early summer of 1918 to give an estimate of the amount they were likely to require during the rest of the year. The total estimate amounted to under 50 tons,—100 tons were actually ordered and made up into floats, and the whole of this was issued and used during the first few weeks of the advance. Further supplies had to come from overseas, and owing to shipping difficulties could not be obtained in time to be of much use.

So valuable were these floats considered by many units that, in spite of their weight after being any length of time in the water, they were frequently lifted and carried forward for re-use. Floats made of oil tins were lighter to carry, but were easily punctured and sunk. *Photograph* LIII. shows a bridge of petrol tins in actual use at Landrecies.

Pontoons are also liable to be damaged by shell fire, but on the whole they suffered remarkably little, and, provided that spare boats and equipment were at hand, damage could be very quickly made good.

Light pile foot bridges were used with good effect by some units, and were quickly and easily constructed when the river bottom was suitable.

A device for rendering pile bridges unserviceable in case of hostile attack is illustrated, and was employed by one Division. Though never actually tested in an attack, its efficiency was demonstrated by bathers catching hold inadvertently and drawing the pins, which were kept well greased. (*Plate* XXII.).

Pontoon and Trestle Equipment. During periods of trench warfare Field Company bridging equipment had been generally stacked under Divisional arrangements in order to avoid frequent moves of unnecessary loads, and also to set free the bridging wagons for carriage of other R. E. Stores.

By the beginning of 1918 nearly every Army had gone as far as to form central Depots where the Bridging equipment of all Divisions in the Army could be parked and looked after. These Depots were

generally at the headquarters of a Pontoon Park. When a Division left the Army, it would collect its equipment from the Pontoon Park, or in certain cases the Park actually delivered the equipment to the Division at its new location.

Difficulties arose during the operations when Divisional reliefs were frequent and rapid, and Divisions would sometimes arrive with no bridging equipment in the area of an Army that was on the point of carrying out an attack.

In cases of emergency, Divisional equipment could always be made good from an Army Pontoon Park, and the Pontoon Park would then demand an equivalent amount from the Base; but the drain on the Base reserves became so great that this system could not have continued indefinitely, and new equipment was not normally issuable from the Base except in replacement of an equal amount certified to be destroyed or beyond repair.

3. Haute Deule Canal.

The following is an account of work carried out by the Field Companies of one Division.

The preliminary scheme was to cross the canal on a 2-Brigade front, each Brigade to have 4 foot bridges ready prepared, as near a possible to the outpost line, which could be easily carried to the canal, and fixed in position.

In addition, under orders from the Corps, 2 Pontoon Bridges were to be thrown across the canal as soon as possible after the Infantry had crossed, and one of these bridges was to be of heavy type to carry motor lorries. Additional pontoons for these bridges were specially allotted to the Division.

Sites for the bridges were selected by means of air photographs supplemented by information from civilians.

Two Field Companies were employed in the work of getting the Infantry across the canal, and each company made four foot bridges, using petrol tin or wood floats. *Plate* XXIII. gives details of a wood float Bridge.

The petrol tin floats took slightly longer to make, but were found much easier to carry to the canal.

Immediately the Infantry had made good the further bank, each company commenced a medium pontoon bridge. The previously selected sites were found entirely suitable, and very little work was needed on approaches. Both pontoon bridges were later converted to heavy type. This work was entirely done by night in bad weather. Each bridge took between 50 and 60 men, ten to eleven hours actual work.

On the same canal an interesting example of a heavy trestle bridge

was made by a neighbouring Division to carry loaded lorries. This bridge did not form part of the original Divisional scheme, and had to be designed and built at very short notice.

A dump of heavy bridging material consisting of rolled steel joists and timber of large section had been formed by the Division from locally salved material, and the bridge was designed to make use of this material.

The first reconnaisance was made at midday on the 16th. September. Work was commenced at 3 p.m. on the following day, and was completed and the bridge opened to traffic at 11 p.m. on the 18th. Two sections of a Field Company were employed with a Company of Pioneers to make up approach roads. Total span of the bridge was 112', and was carried on 7 trestles. Road bearers consisted partly of R.S.J's, and partly of round timber.

Details of this bridge are given on *Plate* XXIV.

4. CANAL-DU-NORD. HASTY BRIDGES CONSTRUCTED BY ONE CORPS.

Preparations were difficult owing to the nature of the ground, and the fact that the approaches to the canal were subject to very heavy machine gun fire.

Information was obtained from maps, plans, aerial photographs, reconnaissance by R.E. Officers on the ground, and also from the air. The canal averaged 100' in width with banks varying up to 15' in height, and depth of water in the wet portions of the canal over 8'.

On about half the front of attack the ground was marshy. The ground on both sides sloped towards the canal.

The scheme provided for seven Infantry foot bridges, and ten crossings for guns and first line transport, five of which were designed to be developed immediately for heavy traffic.

'A' Crossing, (Dry). At zero hour a party was sent out to keep touch with the Infantry, and as soon as the Infantry had cleared the canal, the company started their task, arriving on the work at zero plus 40 minutes. The approaches were only foot tracks, and these had to be first improved. Craters had been blown in the roadway in the centre of each embankment, and the banks were mined at the edge of each crater. One of these mines was exploded by a tank, which became disabled and blocked the passage. Another tank was called upon, and the obstruction quickly removed. The other mines were exploded by guncotton.

The crossing was ready for one-way horse traffic at zero plus 3 hours and 40 minutes.

'B' Crossing, (Dry). A good earth road led up to and from the crossing. A very large crater was blown in the roadway in the centre

of the canal crossing, and a smaller one in the west embankment. The large crater was filled with boards, brick, etc., and earth and chalk from the embankment.

This crossing was ready for one-way traffic at zero plus 1 hour and 30 minutes, and two-way traffic at zero plus 2 hours, and for two-way lorry traffic at zero plus 3 hours.

'C' Crossing, (Dry). A party consisting of 2 Officers and 37 men R.E. arrived at site at zero plus 2 hours and 10 minutes, after being heavily shelled en route.

A very large mine had been blown by the enemy. The crater was filled in with timber and rock, and 2 tanks were put over the crossing to crush in the fill near the bottom.

By zero plus 2 hours and 40 minutes a crossing had been made good enough for the passage of Field Artillery.

Work was continued for the remainder of the day, and a 20' roadway constructed with earth, steel rails, and timber cribbing.

A one-way lorry plank road was completed across the canal by zero plus 8 hours and 25 minutes.

On the second day the cribbing was completed, reinforced and braced. The planking was doubled to make it suitable for two-way traffic, and approaches strengthened.

'D' Crossing, (Dry). Work was started at zero plus 1 hour, and was ready for traffic by zero plus 3 hours and 30 minutes—this work consisted of filling in a road crater 30' diameter and 10' deep on the west bank of the canal.

A temporary diversion was made around the road to allow traffic to pass while the crater was being filled in. The first gun actually went over this crossing at zero plus 3 hours 20 minutes. The crossing was ready for two-way traffic at zero plus 12 hours.

'E' Crossing, (Wet).—Work on this crossing was held up by hostile machine gun fire and shrapnel, and the Officer in charge of the party was wounded.

This crossing consisted of a combined pontoon and trestle bridge of 90' span. Ramps had to be cut through the bank on each side about 20' long. Work was commenced at zero plus 13 hours.

'F' Crossing, (Wet). This crossing consisted of a 60' span pontoon and trestle bridge over the canal, and two 30' trestle bridges over a stream on the east side of the canal.

Work was commenced at zero plus 6 hours and 40 minutes, and completed at zero plus 8 hours and 10 minutes, in spite of enemy machine gun fire.

'G' Crossing. A bridge of 60' span.—Great difficulty was experienced in launching the trestles in the muddy bottom of the canal, which was about 2' to 3' deep in water, but was not suitable for pontooning owing to the number of old piles sticking up in the

water. Work could not be begun till zero plus 9 hours 40 minutes, on account of enemy machine gunners holding out in the swamp east of the canal at this point.

The bridge was finished at zero plus 10 hours 50 minutes.

Between 'E' and 'G' crossings half a company R.E., and half a company of Pioneers had advanced with the Infantry to make hasty foot bridges. The wagons carrying the cork floats came under heavy Machine Gun fire when within 200 yards of the canal bank. Several horses and drivers were wounded, and the teams were unhooked, and wagons pushed down by hand.

Six Infantry foot bridges were thrown across the canal. These were of two kinds—cork pier Bridges, and a 16′ span light trestle Bridge. The cork piers made a firmer bridge when erected, but took rather longer to make as the cork floats were heavy and difficult to carry. The trestle bridge was made of light 16′ span foot bridges resting on light trestles. This was very quickly erected and made a good bridge.

'H' Crossing, (Wet). Trestle and pontoon bridge consisting of 2 pontoons and 3 trestles, 90′ span.

'K' Crossing, (Wet). One Company R.E. constructed a Weldon trestle bridge alongside a demolished culvert, and replaced the culvert by an 18′ span rolled steel joist bridge. These were on the west side of the canal. Work was commenced within half an hour of the attacking Infantry passing this point.

The trestle bridge was completed in an hour and 10 minutes, and the steel bridge was ready for lorry traffic an hour and a quarter later. A second R. S. J. bridge was constructed the following morning to provide for two-way lorry traffic.

As soon as the Weldon trestle bridge had been completed, half the company went forward to the canal, and constructed a medium pontoon bridge 120′ long. This was open to traffic less than 3 hours after work on the trestle bridge had been completed.

A second Field Company constructed a D. type heavy pontoon bridge for lorry traffic on the other side of the demolished road bridge. This bridge was 120′ long, and considerable work was also required on the approach ramps. The whole job was completed in about 5½ hours' work.

Work of the R.E. of another Division in Crossing the Canal-Du-Nord. The Infantry attack was made by one Brigade, and two Field Companies had been detailed to carry out bridging across the canal and a stream to the East of it.

The Infantry attack was held by heavy machine gun fire from woods on the west of the canal. Both Field Companies, however,

extended and worked their way round and through these woods and succeeded in capturing the canal bank together with a number of prisoners.

One Company reached the canal at 11.30 a.m. and the other at 12.45, both being well ahead of the leading Infantry.

The first company completed a cork raft and plank foot bridge across the canal and marsh by 12 midday, and an Infantry foot bridge across the river by 1.45.

The second Company found the canal no obstacle to foot traffic, and completed an Infantry bridge across the river by 2.5 p.m.

The Infantry did not actually advance beyond these crossings until 5 p.m. and it was impossible to bring up pontoon wagons to the canal till after dark.

A medium pontoon bridge was commenced after midnight by the third Field Company, with an Infantry working party cutting through the banks to make approach ramps.

The work was all completed by 5 a.m.

On the front of another Army the Canal formed the dividing line between the British and German troops.

A particularly fine bit of work was done by a Field Company during the nights preceding the attack in the construction of a trestle bridge for Artillery and first line transport across the canal within a short distance of the enemy.

A section of the canal was taken at day-break, and gave the following measurements—width between towpaths 79′ 6″—width of bed of canal (dry bottom, brickwork) 40′ 6″—depth of Canal below towpath 15′ 6″.

The Field Company was organised in teams, each team being responsible for the construction of 1 trestle plus 1 bay.

As many fastenings as possible were designed to be by means of bolts, and great care was taken that these should fit easily, and only require to be pushed through.

Road bearers were notched to fit over transoms, and blocks were also nailed on transoms at the required distances, so as to avoid having to make any measurements on the night of operations. The material was carried to within 300 yards of the site on pontoon wagons, and then carried by hand along the canal, and distributed under cover.

Two nights before the advance sites were cleared out for the 2 shore trestles, and the trestles were placed in position and left leaning against the wall of the excavation. Shore transoms were also fixed into position, all being covered with scraps of canvas etc.

On the following night two of the larger trestles were assembled and left leaning against the brick walls of the canal.

On the night before the advance the Company, organised in their trestle teams, started work about 8.15 p.m. and completed the bridge by 1.15 a.m., roughly four hours before zero. In the original scheme it was ordered to be completed within four hours after zero.

Although the enemy line was only 500 yards away, work went on without any interruption, owing to the very complete previous arrangements, and the complete silence that was maintained every night.

This fine piece of work enabled the Divisional Artillery to follow and come into action immediately behind the attacking Infantry, and had great influence on the success of the operations.

Photograph LIV. shows a crib and trestle bridge for lorries constructed by a Field Company, and *Photograph* LV. shows a trestle bridge alongside a typical ramp for tanks.

5. THE ESCAUT CANAL AND RIVER.

The following is an account of the work of one Company in assisting an Infantry Brigade to force the passage of the canal.

The work consisted of:—

(1). Reconnaissances and preparations to throw floating bridges (cork) over the canal, and to furnish rafts and boats to enable the Infantry to cross when opportunity permitted.

(2). Actual putting over of 1 cork float bridge, and furnishing of rafts; making passage over debris of old lock and bridge.

(3). Repairs of 2 destroyed foot bridges, and salvage of material.

Reconnaissances were made on the front of both attacking battalions, and the necessary material was brought up by lorry and carrying parties.

On the left battalion front the bridge was constructed in the courtyard of a mill with gates facing on the canal bank covered from view, some measure of protection being thus secured. Water in the canal was high, and the approaches ideal. On the right battalion front the approach and carrying were very difficult. A spot was selected, and preparations made to bridge if it should become possible.

The Piers of the bridge (cork) were also fitted with an extra bale of cork to give sufficient buoyancy to allow their use as rafts if this should prove more feasible than the completion of the bridge. Paddles, etc., were held in readiness. Another alternative was the possibility of crossing on the debris of a destroyed bridge.

At zero on the day of attack the bridge on the left Battalion front was successfully put across.

The gates were flung open, and the bridge carried bodily to the water's edge and pushed over. The carrying party were actually the first Infantry to cross. During the operations the bridge broke, but was held together by hand until the first troops were over. No delay was caused, and it was afterwards repaired.

On this battalion front 6 cork rafts, each made from 3 bales of cork, were also used to ferry men across.

On the right battalion front the leading troops of Infantry and Sappers found the debris of the old bridge and lock passable—no new bridge was constructed, but the old crossing was improved.

Tank crossings.—Two tank crossings were constructed by one Field Company over the river and canal, each consisting of three 20′ spans, the standard 22′ rolled steel joist tank bridges being supplied direct from the Army Bridging Depot. In each case the canal crossing was effected by one span across the lock.

Bridges for the first crossing did not arrive until after dark, and were only brought up by lorry with the greatest difficulty and exertion. Work was commenced at 9.30 p.m. and went on continuously until 7 a.m. the following morning, when all three bridges were completed.

One section R.E. worked on each bridge, and the ramps were made by two platoons of Pioneers.

Considerable shelling went on all night, and the company had 12 casualties at the very beginning of the work, which made them shorthanded.

One bridge of the second series arrived at 10 o'clock the following night, and this was unloaded and erected by 1 a.m. in spite of continual shell fire. The other two bridges arrived the following afternoon, and were completed with ramps by midnight—in this case the lorries could not approach the site, and a long carry was required, which took much extra time.

The following extracts from the War Diary of a C.R.E. Division describe the bridging work done by the Field Companies for the crossing of the canal and river:—

September 28th.—Headquarters R.E. and Field Companies moved to 'F'.—All pontoon equipment was moved to 'F', and during the night Officers went forward to reconnoitre forward area, and river and canal.

September 29th.—Early in the morning the advance section of 'A' Field Company constructed a foot bridge over the canal from old German floats found lying about, and passed a battalion of Infantry over.

Officers of the three Field Companies made detailed reconnaissances of the canal and river.

Another foot bridge was put across the canal by 'A' Field Company.

At 4 p.m. a pontoon bridge to take transport was put across the canal by the 'B' Field Company.

The 'C' Field Company repaired three existing Bridges across the river and canal, and also put a medium pontoon bridge over the canal.

September 30th.—'A' Field Company put across another foot bridge, and repairs to an old German bridge were carried out, and this bridge made passable for both transport and 4·5 howitzers.

'C' Field Company reconstructed existing light bridge to take 60 pounders.

'B' Field Company constructed a new trestle bridge over the canal, and a trestle bridge over the river was strengthened to take 60 pounders.

October 1st. and 2nd.—'A' Field Company commenced the construction of a trestle bridge to take lorries over the river—other companies were employed on the maintenance and strengthening of existing bridges, which was necessary owing to the heavy shelling. Approaches to bridges were improved.

October 3rd.—Trestle bridge was completed by 'A' Field Company. (*Photograph* LVI.).

'B' Field Company commenced two trestle Bridges over the river, and a pontoon bridge over the canal.

All three bridges were completed by 9.30 a.m.

October 4th and 5th.—Maintenance of existing bridges, and of plank road leading to lorry bridge.

October 6th.—'B' Field Company commenced preparation for the construction of a 60′ steel girder portable road bridge over the River.

The other two companies continued maintenance work, and the 'C' Field Company put another pontoon bridge across the canal.

October 7th.—Owing to the advance being continued, work on the girder bridge had to be suspended. Companies concentrated on the work of strengthening existing Bridges to take additional transport.

October 8th.—During the night 7th/8th it was reported that the water level in the canal was falling. Reconnaissances were made and this was found to be the case. Urgent messages were sent out to the companies instructing them immediately to replace all existing pontoon bridges by trestle bridges.

'C' Field Company replaced two pontoon bridges over the canal with trestles, and 'A' Field Company erected a new trestle

bridge over the canal. These bridges were all completed by 5 p.m. and very little inconvenience was caused to traffic.

October 9th.—Canal bed repaired where culvert had been hit by shell, thus lowering water level.

'A' Field Company commenced the construction of a heavy trestle bridge to take lorries, and 'B' Field Company continued the construction of the steel girder bridge.

'C' Field Company concentrated on maintenance.

October 10th.—Work continued as on 9th.

October 11th.—Heavy trestle bridge and steel girderbridge both completed.

Practically all bridges were constructed and repaired under heavy enemy shell fire. Timber had in many cases to be salved from old bridges, and a great deal of work could only be done by night.

On the front of another Division where the attack was made by one Brigade, arrangements were made for ferrying the Infantry across the river in 25 improvised canvas covered boats, simultaneously with the construction of 4 floating foot bridges.

The foot bridges were designed to carry Infantry in single file at 3 yards interval, and were composed of 10′ duck-boards on floating piers of German torpedo floats—the average width of the river was 100′.

Two Field Companies were told off for the work, two sections of each company being employed in ferrying, and the other sections each making a foot bridge. These latter sections each had a working party of one platoon of Pioneers attached to them.

The boats were most successful,and it was found possible by means of 12 boats to transport an entire battalion across the River before the foot bridges were ready.

Immediately the crossings had been made good, work was commenced on a timber trestle bridge with R.S.J's as road bearers to carry 17 ton axle load. Schemes for all this work had been very carefully prepared beforehand, and no hitch occurred in the actual execution.

Another Division ferried the leading Infantry across on four different types of raft, which are illustrated.

Type A. This was constructed of an ordinary bivouac sheet 13′ × 10′ wrapped round a wooden crate outside of which facines made of reeds and straw were fixed to provide extra buoyancy. The chief points of this type were stability, and absence of noise when being propelled through the water.

The sheets are apt to become waterlogged, but are sufficiently waterproof to serve for a hurried crossing up to 8 or 10 hours immer-

sion. This raft can be lifted and carried by 4 Sappers. (*Plate* XXV.).

Type B. This is an ordinary German pattern formed by 2 piers of 2 floats each, and is capable of carrying 3 fully armed men. It has the advantage of low freeboard and comparative absence of noise. (*Plate* XXVI.).

Type C. Explains itself. It is fairly rigid but is comparatively very heavy. (*Plate* XXVII.).

Type D. Is more unstable than Type C. and there was doubt as to its suitability—it was, however, used quite successfully on one sub-sector. The propulsion was by means of a tow-rope, and not by paddles. (*Plate* XXVIII.).

Plates XXIX. and XXX. give details of two bridges erected by Canadian Divisional Engineers, and *Photograph* LVII. shows a R.S.J. and trestle bridge to carry tanks built by a Field Company of another Division.

6. River Selle.

The crossing of this river involved probably more arduous work for the Divisional R.E. than that of any other.

The following extracts from the Report of an Army Chief Engineer give a good idea of what was done :—

"During the period October 10th to 19th foot bridges of varied type, cork float, light trestles, duck-board and petrol tin bridges were erected at intervals along the whole Army front. All pontoon equipment was brought up, and numerous crossings for Infantry made.

These bridges were mostly protected from enemy fire by the height of the river banks, but the pontoons proved very vulnerable during the journey up to the line.

At one time over 30 pontoon bridges were in position on the Army front ; a wonderful total if it is considered that the river was practically the dividing line between the two Armies. Work was often done within 50 yards of the enemy, who kept up a constant machine gun and artillery fire on the river. Heavy casualties were often inflicted on Field Companies engaged, but the work was invaluable.

Preparations were now made to cross the Selle river on the 20th October.

It was essential for the success of the attack that the enemy should remain in ignorance of our intentions—it was decided therefore to postpone all work until the night of the 19th/20th October. During the preceding night bridges of all types were brought up and concealed near the sites, and the work of construction commenced immediately darkness fell on the night of 19th October.

On all Corps fronts the plans adopted were similar. It was decided to increase the number of foot bridges until a minimum of 1 per 100 yards of front was in position.

Light trestle bridges were to be erected in various places to allow the passage of field guns, and heavy bridges of the R. S. J. Type were to be placed in position as soon as the attack was seen to be successful.

On the "W" Corps front many foot bridges and pontoon bridges had been placed in position by the R.E. of two Divisions. On the night of the 19/20th October these bridges were increased in number until there were 20 on the Corps front.

During the night R.E. of one Division erected Weldon trestle bridges over the river at two points to take field guns.

These bridges were successfully used by the attacking forces, and the R.E. were able to commence the erection of heavy bridges on the morning of the 20th.

On the "X" Corps front the scheme for the attack of one Division necessitated the construction of foot bridges above and below the town of Solesmes. Surprise was essential—there was to be no preliminary bombardment, and the construction of bridges was to be put off until the last moment. Information was scanty owing to the fact that the enemy outposts were so near the chosen bridge sites.

It was decided to erect 8 foot bridges north of the Town, and 4 to the south. Later 2 pontoon bridges were to be erected over the river to carry field guns. The material for these bridges was brought up and concealed near the sites.

The erection of the foot bridges commenced soon after midnight on the 19th. All bridges were completed before zero hour, and the operations were entirely successful. Slight floods were caused by debris damming the river, but the foot bridges were lengthened and the difficulty overcome.

To ensure that the position of the bridges was obvious to the Infantry, the bridges were marked with tapes and small red lights placed in position.

On the 21st October trestle bridges for horse transport were erected over the river at four points.

On the 23rd October R.S.J. spans were erected over the river at Solesmes.

On the front of another Division foot bridges were made of various types, and work began at 10 p.m. on the 19th. The heavy rains rendered work difficult, but all the bridges were thrown across successfully without alarming the enemy.

Great credit was due to the good discipline of the men, who preserved absolute silence, and to the avoidance of any splash in

placing the piers. The organisation worked smoothly, and from midnight onwards one bridge was brought down to the river every 10 minutes on each brigade front.

Two Field Companies then undertook the construction of 2 pontoon and trestle bridges at zero minus 1 hour.

The construction of a heavy tank bridge was undertaken by the third Field Company—it was erected under considerable difficulties, but in spite of heavy gas shelling and rain, the work was completed on the same day.

On the "Y" Corps front the R.E. of one Division had during the week preceding the attack placed many foot bridges and pontoon Bridges in position.

On the night before the attack 2 pontoon bridges and 4 light foot bridges were erected, in spite of considerable shelling and machine gun fire which caused many casualties, and a gas concentration, which necessitated the use of respirators for some hours.

On the day of attack bridging operations were divided between two fresh Divisions.

The approaches to the river are very difficult to traverse during the night on account of their openness. To obviate this tapes were laid down with notice boards to each bridge-head, and lamps lit which gave a red light to the rear.

On the day of attack the bridges were successfuly used by the Infantry, and R.E. of both Divisions were able to commence the erection of other types of bridges.

In addition to 16 foot bridges—2 Pontoon bridges, 2 trestle bridges for horse transport, and 1 R. S. J. tank bridge were erected.

On the "Z" Corps front the procedure was slightly different.

As with the other Corps, foot bridges and pontoon bridges had been erected along the whole front usually under very difficult circumstances, but assisted by the fact that the Infantry had established themselves slightly to the East of the river.

Bridging operations were shared by two Divisions.

On the night of 19th October a heavy tank bridge was completed across the river Selle North of Neuvilly in 1 hour, 45 minutes, the material having been previously brought to the site and concealed.

On the 17th and 18th October field Companies of one Division erected 24 foot bridges, the work being of an extremely difficult nature owing to the proximity of the enemy, and the very light nights. Tank bridges were erected by Field Companies of the same Division.

One Field Company completed their bridging on the night 16th/17th, working breast deep in water for several hours under

shell and machine gun fire, with the enemy's flares falling within 20 yards of the site.

Another Field Company erected a tank crossing consisting of sleepers threaded on iron rods, the work being completed on the night 19th/20th: being under the surface of the water it was not discovered by the enemy.

On the morning of the attack these bridges were successfully used by tanks, and close co-operation with the attacking Infantry greatly assisted the advance.

Two of these crossings were afterwards destroyed by enemy fire.

Half an hour after zero on the 20th, R.E. of the other Division erected trestle bridges for H.T. north and south of Neuvilly.

Later in the day heavy bridges were constructed in Neuvilly, one for Tanks and one for 12-ton axle load.

Both bridges were completed by the 22nd of October, in spite of direct hits while under construction.

One Field Company erected 2 trestle bridges for H.T. and one medium pontoon bridge, in the course of which 50 per cent of the Company became casualties."

The following is an extract from the report by the C.R.E. of one of the Divisions engaged, which gives in greater detail an account of work carried out:—

o o o o

"Reconnaissances were carried out on the night of the 17th, and the width of the river at water level estimated to be about 25', depth 3' to 4', banks very steep 6' to 10' high, and quite unclimbable by Infantry in fighting order.

The bed of the river had 1' to 2' of mud. It was decided that the northern set of bridges should consist of 6 light trestle bridges, and 2 cork bridges carrying Infantry in single file.

In addition, in case the bridges should fail, 4 wire netting mats were to be laid across the river to allow men to walk through the water over the mud.

Ropes were to be laid across the river at these crossing places from top to top of bank, to enable men to pull themselves up the steep banks.

Scaling ladders 10' high were also given to the Infantry for the same purpose.

Owing to the necessity for absolute silence throughout the operations, and the steepness and height of the banks, petrol tin bridges, light pontoon bridges, and barrels were ruled out.

The night of the 18th/19th was used for carrying up material, and setting it out into bridges.

The carrying party of the Pioneer Battalion was organised in such a way that each party knew exactly what it had to do.

The party was attached to a Field Company for two days before the operation, and was given all possible instruction in handling the material, which had to be carried about 700 yards from the wagons.

On the night of the 19th/20th, zero hour having been fixed for 2 a.m. on the 20th, the erection of the bridges was started at 1.30, and completed at or before zero in every case.

A single cork float bridge was completed half an hour before zero to enable a Company of Infantry to pass over as covering party—the company lay under the far bank of the river. The Infantry passed over the bridges without a check of any kind, and the operation was completely successful.

The limits for the southern set of bridges had been decided by reconnaissance on the night of the 17th; a second reconnaissance on the night of the 18th showed that the river had risen several feet owing to the enemy having dammed it between the northern and southern bridging places, and the sites for the Southern bridges had to be moved.

It was decided to make 2 petrol tin, and 2 cork float bridges on the night of the 19th, all the material having been carried up in the same way as for the northern bridges to the site of the work.

Bridging was started at 11 p.m. on the 19th. It was found that the river had risen still further, and the bridges were not long enough to span it—their number was accordingly reduced to 3, and an existing foot bridge patched up to serve as a fourth—the operation was quite successful, and the Infantry passed over without a check in due time.

The light trestles which were used were made out of hexagonal 16′ signal service telegraph poles.

They were 4 legged, with transoms 7′ 6″ above foot of legs; the legs were splayed out 2′ 6″, each pair of legs 4′ 6″ apart.

Angle iron pickets were used as ledgers in order to sink the trestles—all lashings were of wire.

Trestles were stiffly cross braced and made up complete with the lashing fixed to the transoms before leaving camp.

The footways for the trestle bridges consisted of 2—15′ duckboards 2′ wide, runners 3″ × 3″, slats 3″ × 1″ placed 1½″ apart. The duckboards thus formed were stiffly trussed underneath with heavy telegraph wire windlassed tight. Each trestle was carried out into midstream by 2 men wading, and stuck into the mud without difficulty.

The cork bridges were formed of 3 piers of cork at 7′ centres, and the centre pier was anchored back to each bank.

The wire netting mats were made of German wire netting 1 metre wide with slats $1\frac{1}{2}'' \times 1''$ fastened on the top side of the wire 18″ apart. These were fixed down with screw pickets at the shore end, and rolled across the bed of the river by a man wading along and shoving the roll in front of him with his foot, and picketed down on the far bank. Slung ropes were placed alongside each mat to guide men over, and help them down and up the banks. These mats were not used owing to the success of the bridges.

Petrol tin floats in pairs were made with 2 frames each holding 24 tins spaced at 9″ centres, tins being encased in a crate of rabbit wire, and wedged tightly in a $3'' \times 3''$ timber framing.

At the southern site mauls muffled with sandbags could be used to drive pickets, but at the Northern site screw pickets had to be used.

Some specially strong kite balloon screw anchorage pickets were obtained, and found very successful on the northern site.

Absolute silence was necessary as the nearest enemy post was found to be only 50 yards off.

The approaches to the bridges were marked with tapes.

The river ends of the approaches were marked with number boards painted white on black 1′ square, the other ends were marked with petrol tins punched with corresponding numbers with candles in them. These candles were quickly put out by shelling, but the moon gave sufficient light for the tapes to be found.

Organisation of the work was based on each party of R.E. having it's own working party of requisite strength, and having one job only to do; thus, each trestle Bridge had 5 sappers and 10 carriers, each cork float Bridge had 6 sappers and 12 carriers, each wire netting mat had 3 sappers, and so on."

A Standard R.S.J lorry bridge built by a Field Company is shown on *Photograph* LVIII., and a lorry bridge of salved material on *Photograph* LIX.

Tank Bridge Over the River Selle. A crossing for tanks constructed entirely of old railway sleepers was made by one Company—details are shown on *Plate* XXXI.

The most important feature of the design is the strutting cribs against the banks.

If the bottom of the stream had been soft mud, sills would undoubtedly have been necessary.

In this crib a total bearing of about 40 square feet was available, one-third to half of which would probably have to take the total weight at a time.

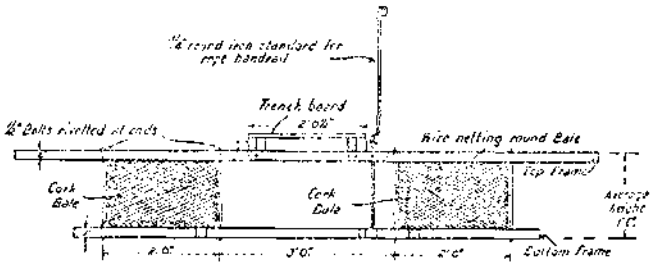
The actual settlement of the cribs after 4 tanks crossed was about 6″. The timbers of the crib were held in position by 1½″ diameter rods which were driven into the bottom of the river.

The crib was built up to the surface of the water, the sleepers being bored and fitted over the rods until the required height was obtained—12″ being allowed for sinkage under the weight of the tank. The crib was weighted with pieces of iron rail, to keep it in position.

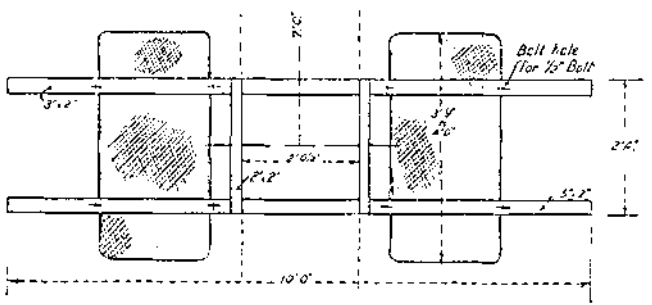
This work was all done by night in close proximity to the enemy.

Details of this work are given on *Plate* XXXI.

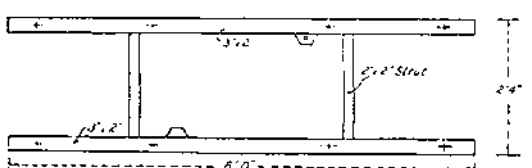
(To be continued).



SECTION OF PIER



PLAN OF TOP FRAME OF PIER



PLAN OF BOTTOM FRAME OF PIER

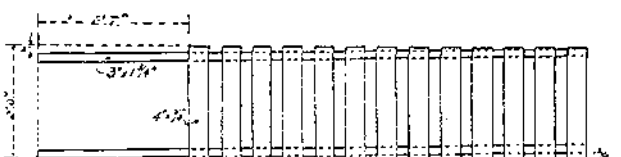
Piers at 7 feet centres will carry fully equipped infantry in single file The Cork Bales are squared up and tightly bound in wire netting, 1¼" to 2" mesh, before being compressed between the frames.

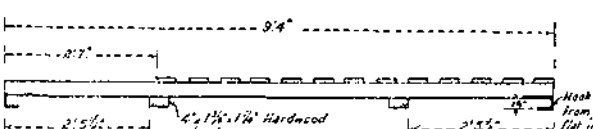
NOTES:-

(1) Average Weights:

Cork	2 x 75 lbs.	150 lbs
Top Frame		39 "
Bottom frame		24 "
Bolts		3 "
Grating		47 "

(2) Buoyancy of Pier. 430 lbs.
(3) Four Bays with superstructure, pack on a pontoon wagon.
(4) The ½" Bolts require to be made specially.
(5) Wooden crates have been used to contain the Cork, but are of course much heavier than the wire netting.
(6) Cork Slabs are superior to Cork Chippings.
(7) ¾" to 1" Steel cables are preferable to hemp cables as anchorages, as the latter are easily damaged by shell fire.



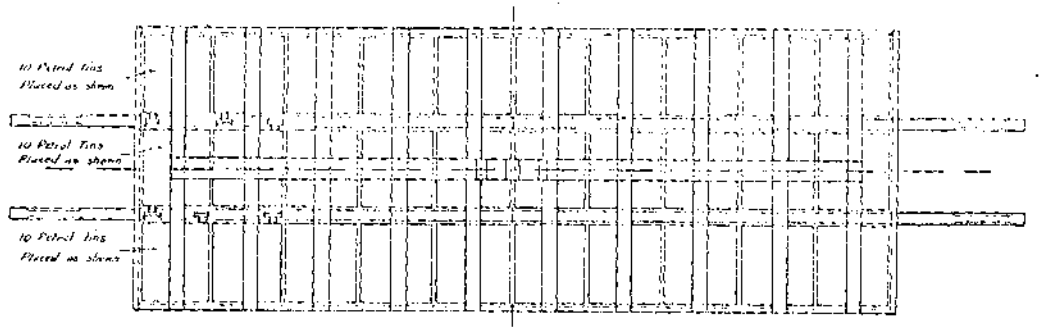


TRENCH BOARD

CORK BRIDGE PIERS.

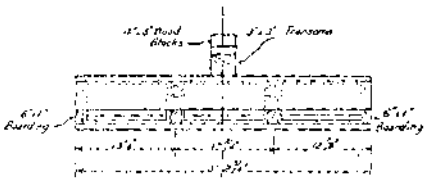
PLATE XX.

PONTOON (PETROL TIN FLOATS). PLATE XXI.

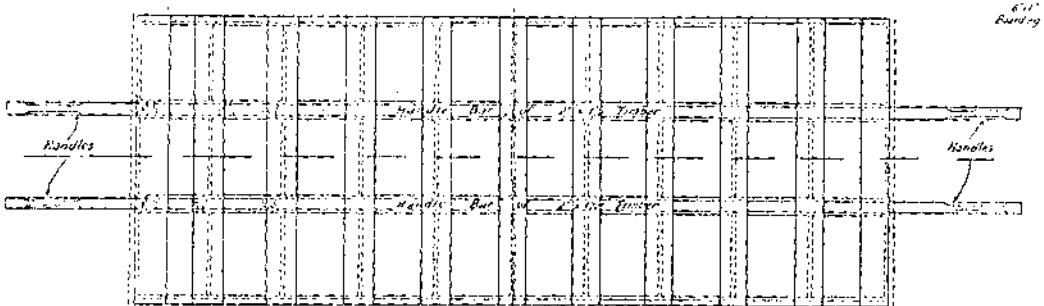


PLAN of TOP

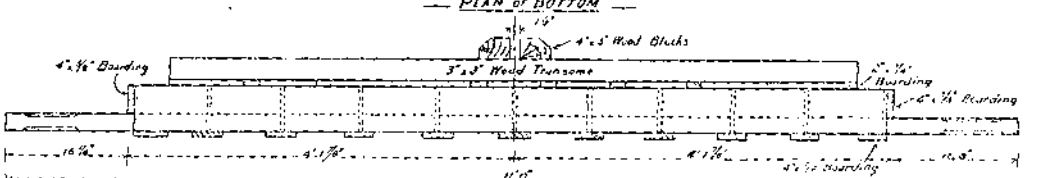
All connections simply nailed with wire nails in suitable lengths.
Holding of Petrol Tins "hooked on" when placed in Frame.



END ELEVATION



PLAN of BOTTOM

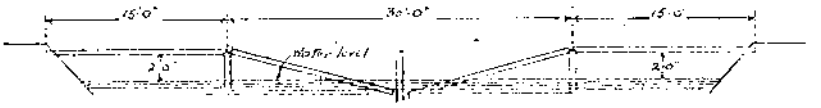


SIDE ELEVATION

PILE BRIDGE FOR INFANTRY. PLATE XXII.

SHOWING ARRANGEMENT FOR DROPPING ROADWAY

When either pin is withdrawn, the transom falls and the two ends of the roadway resting on this transom fall into the water; the other two ends of the roadway still rest on the fixed transoms as shown.

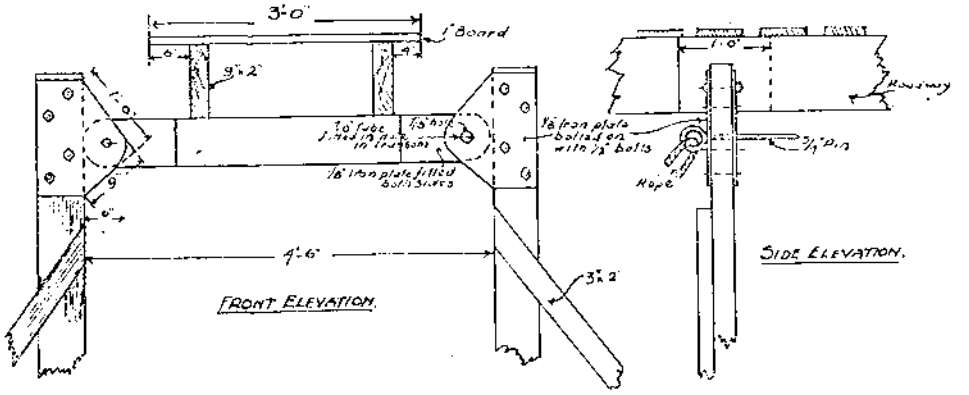


LONGITUDINAL ELEVATION. ½in. to Scale.

The gap made measures 30'; anyone putting his weight onto the collapsed roadway would be precipitated into the water.

If completely displaced from the other transoms which is quite possible, the roadway would float.

The collapsed roadway is not fastened in any way to the fixed transoms, and would form a most insecure basis for any improvised bridge.



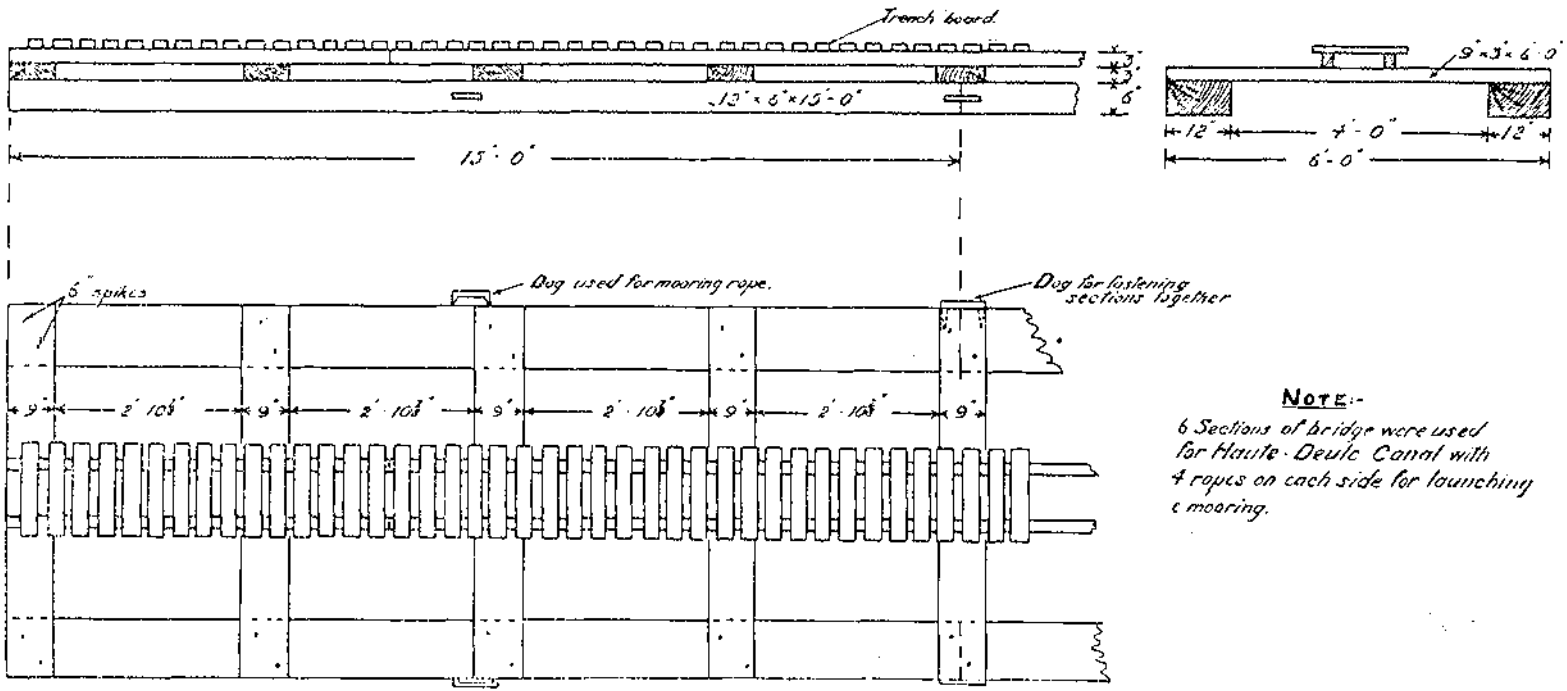
FRONT ELEVATION.

SIDE ELEVATION.

SKETCH SHOWING ONE SECTION OF FLOATING FOOT-BRIDGE.

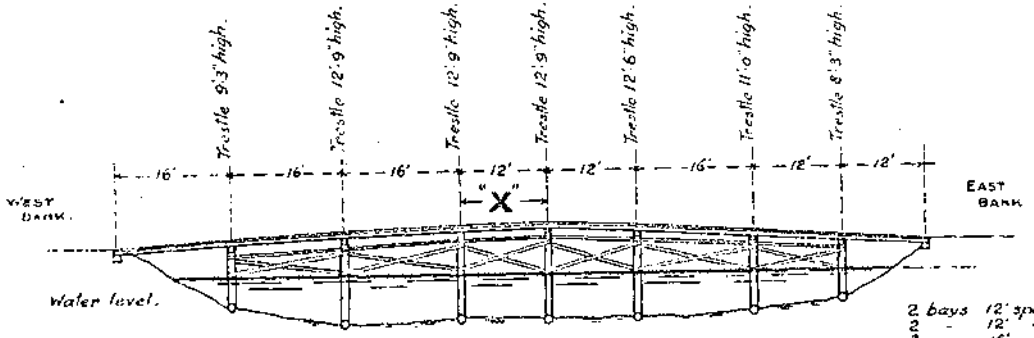
PLATE XXIII.

TRANSPORT OF INFANTRY IN SINGLE FILE OVER HAUTE-DEULE CANAL. OCT., 1918.



NOTE:-

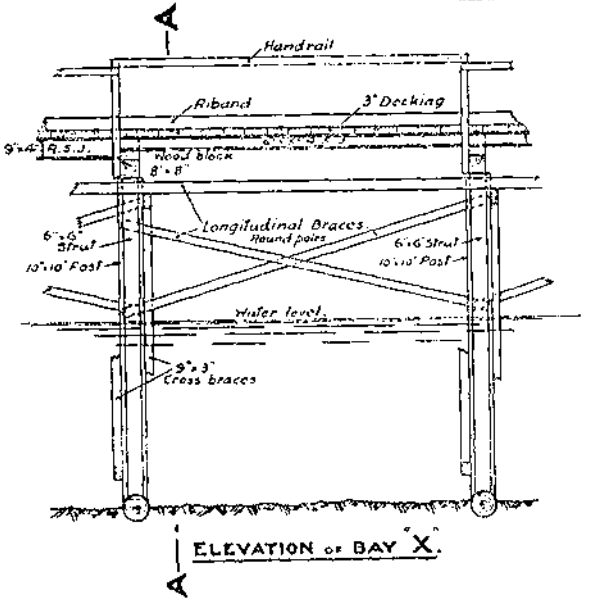
6 Sections of bridge were used for Haute-Deule Canal with 4 ropes on each side for launching & mooring.



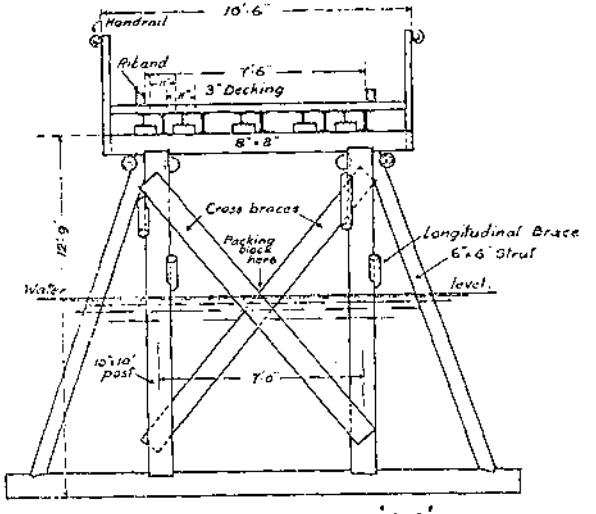
SKETCH ELEVATION OF BRIDGE.

NOTE:-

2 bays	12' span	supported on	6"×5" R.S.J.s.
2 "	12' "	"	8"×8" timber Beams.
3 "	16' "	"	9"×4" R.S.J.s.
1 "	16' "	"	9"×4" " and Round Timber



ELEVATION OF BAY "X".

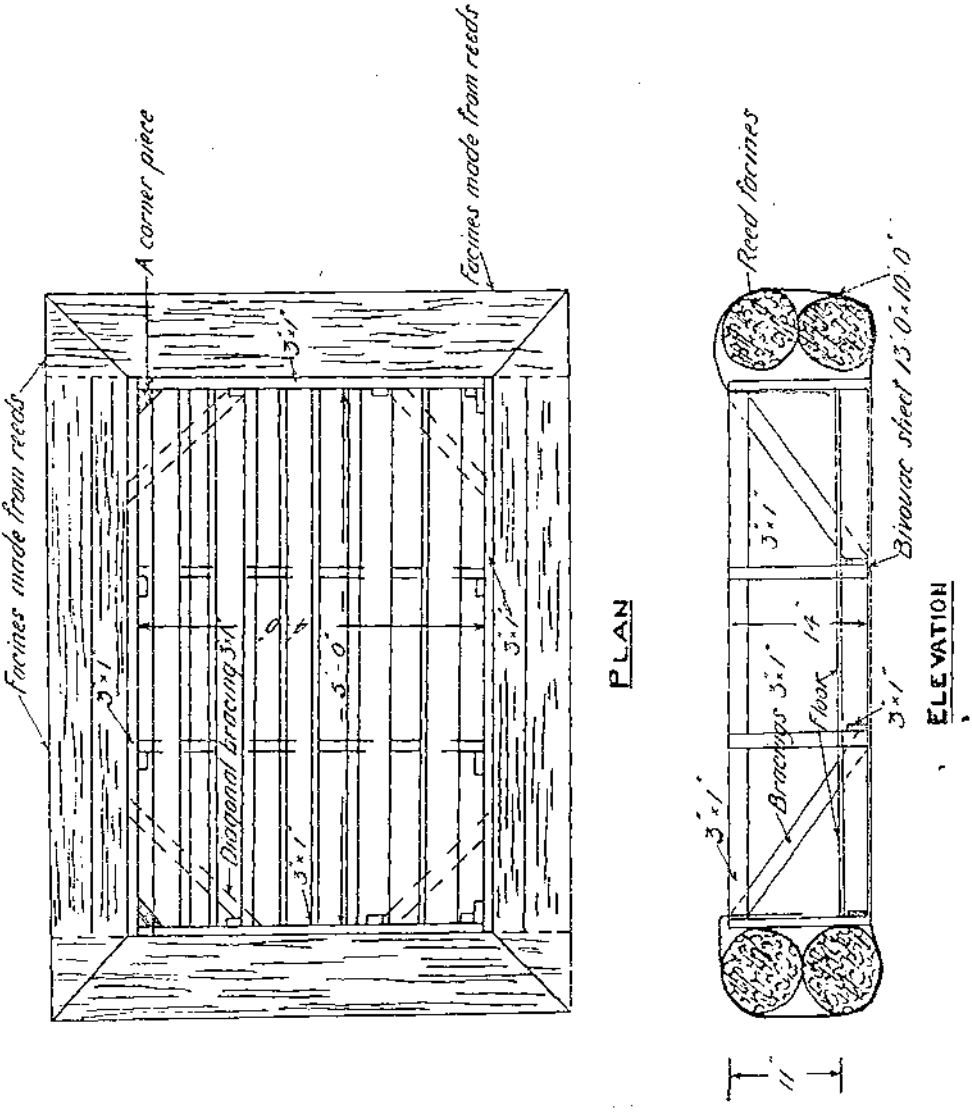


TRANSVERSE SECTION 'A-A'.

PLATE XXIV.

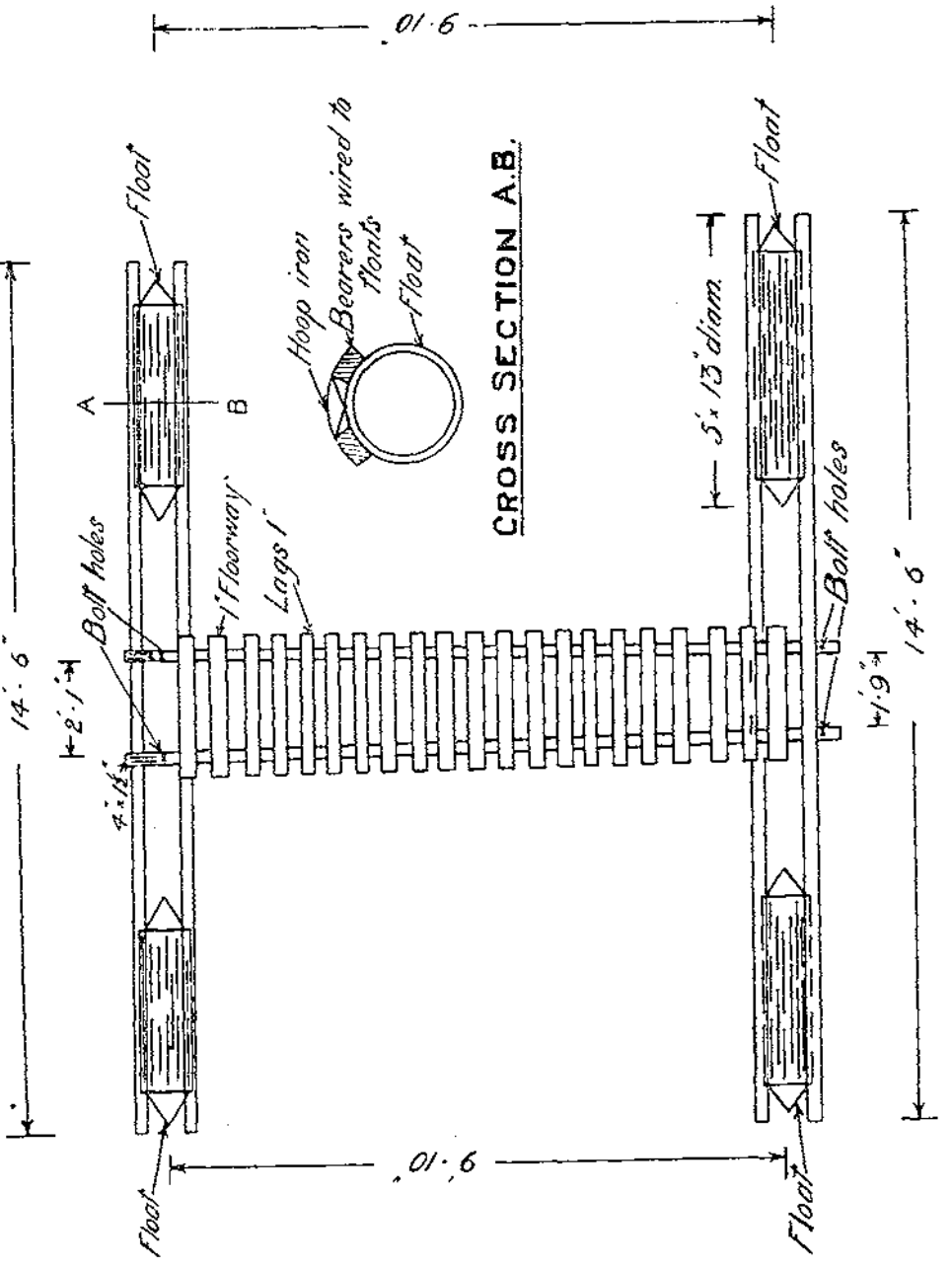
RAFT TO CARRY 4 MEN. PLATE XXV.

REQUIRES 4 MEN TO CARRY AND LAUNCH.



RAFT TO CARRY 3 MEN. PLATE XXVI.

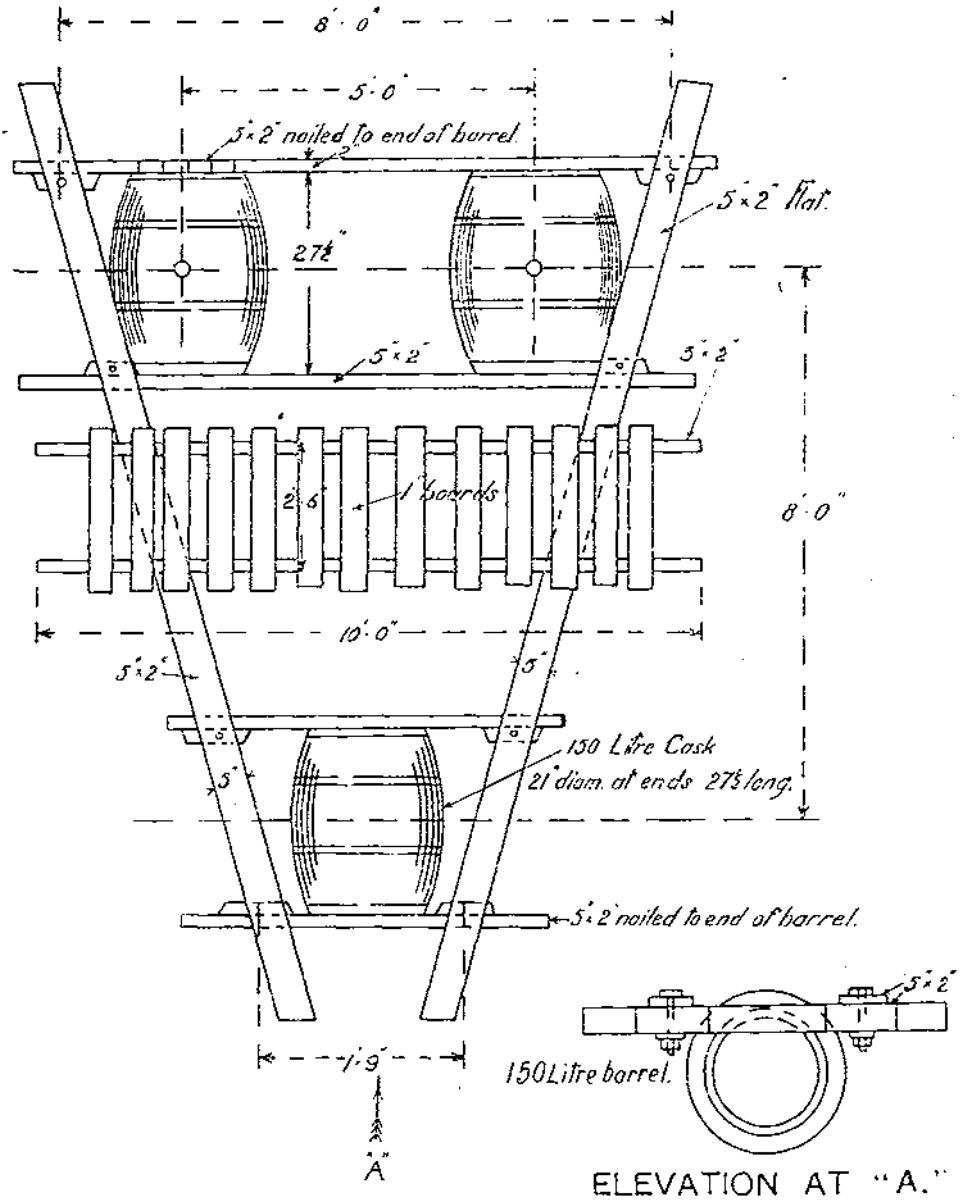
REQUIRES 5 MEN TO CARRY OR LAUNCH.



RAFT TO CARRY 3 MEN.

PLATE XXVII.

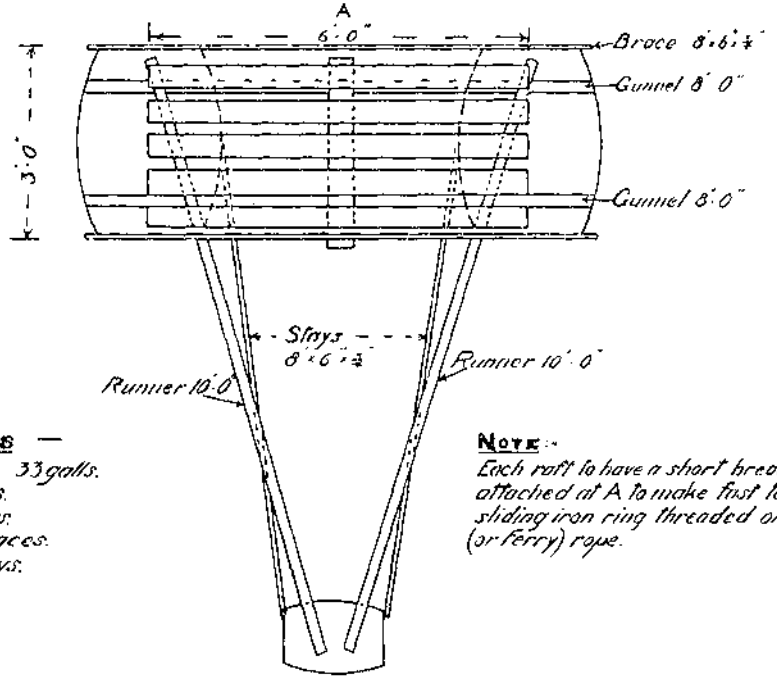
REQUIRES 7 MEN TO CARRY OR LAUNCH.



ELEVATION AT "A."

CATAMARAN FOR RIVER CROSSING AT ESPAIN.

PLATE XXVIII.

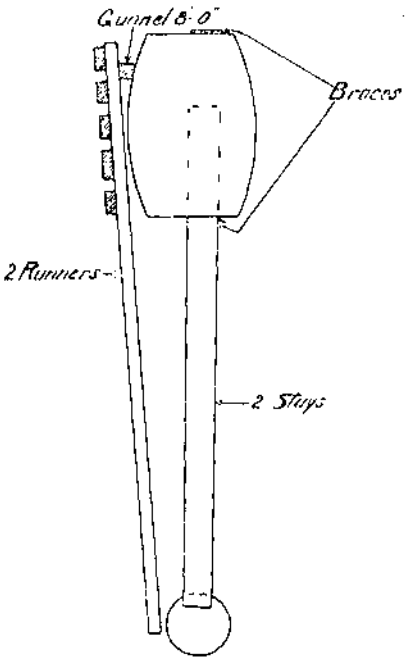


PLAN

— MATERIALS —

2. 150 L. Casks 33 galls.
2. 8ft. Gunnels.
2. 10ft. Runners.
2 8"x6"x4" Braces.
2. 8"x6"x4" Stays.
1. 50 L. Cask.
Decking 6"x3".

NOTE:-
Each raft to have a short breast-line attached at A to make fast to a sliding iron ring threaded on Tow (or ferry) rope.

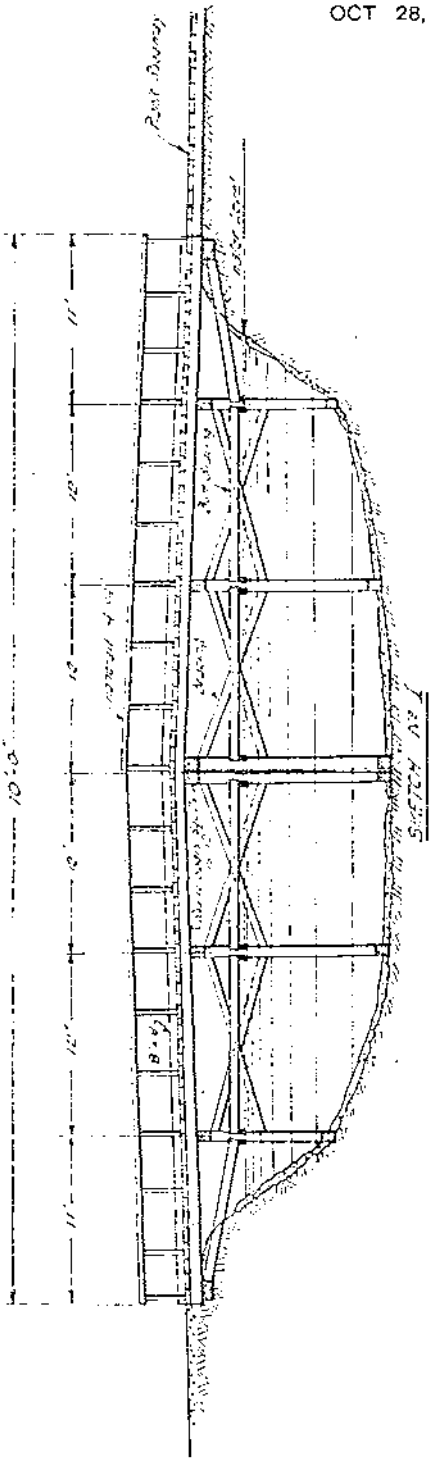


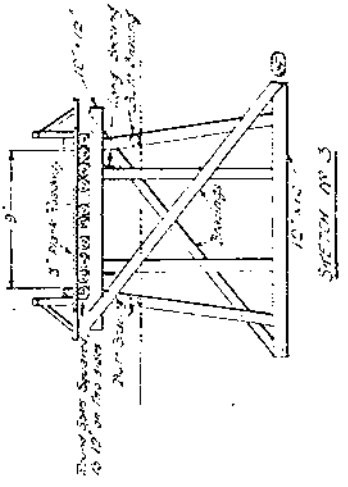
END ELEVATION

PLATE XXIX.

PLAN OF TIMBER TRESTLE BRIDGE AT PROUVY.

OCT 28, 1918.





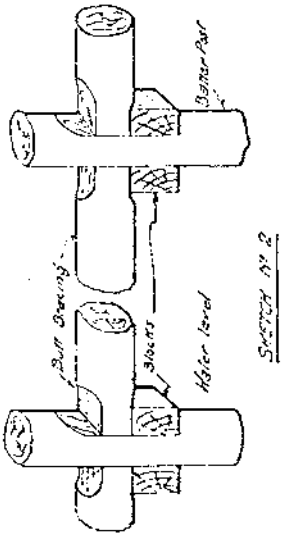
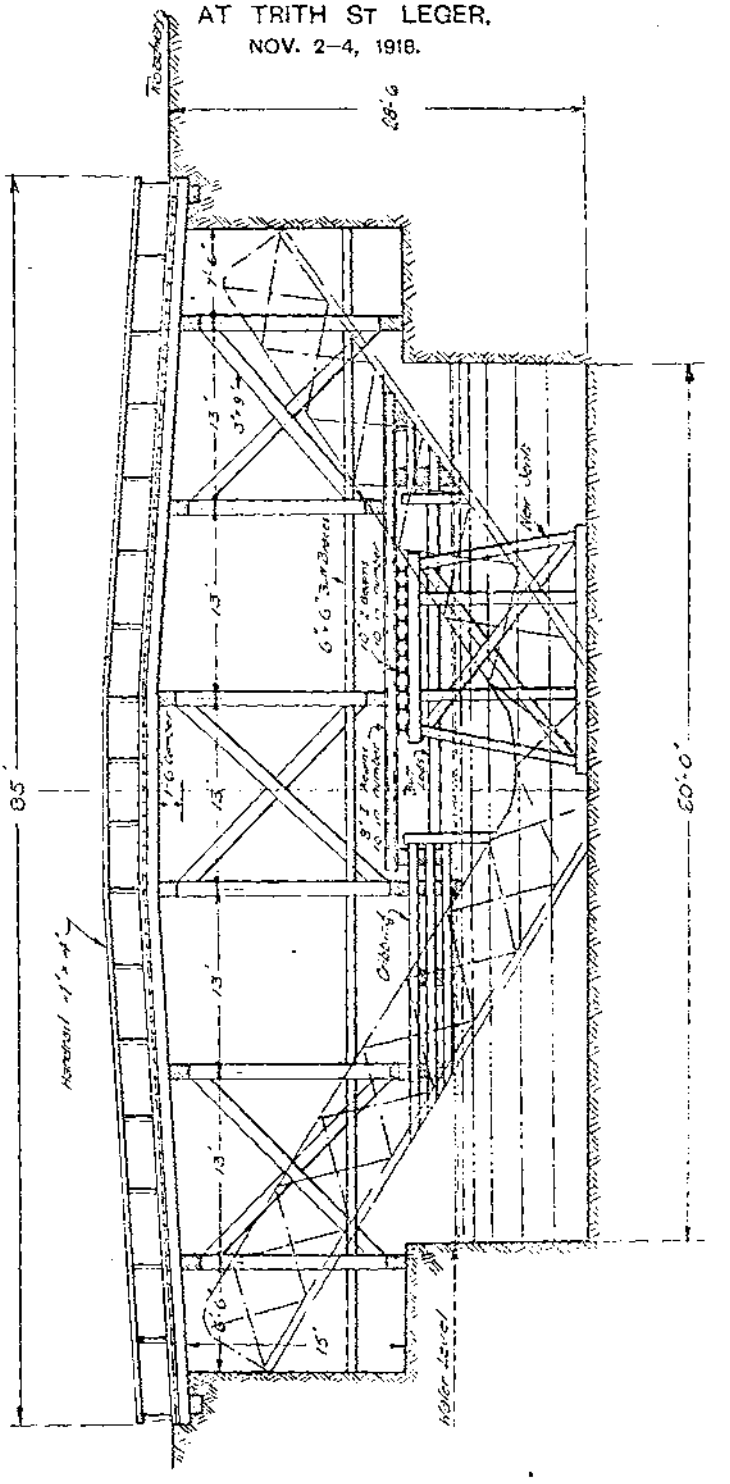


PLATE XXX.

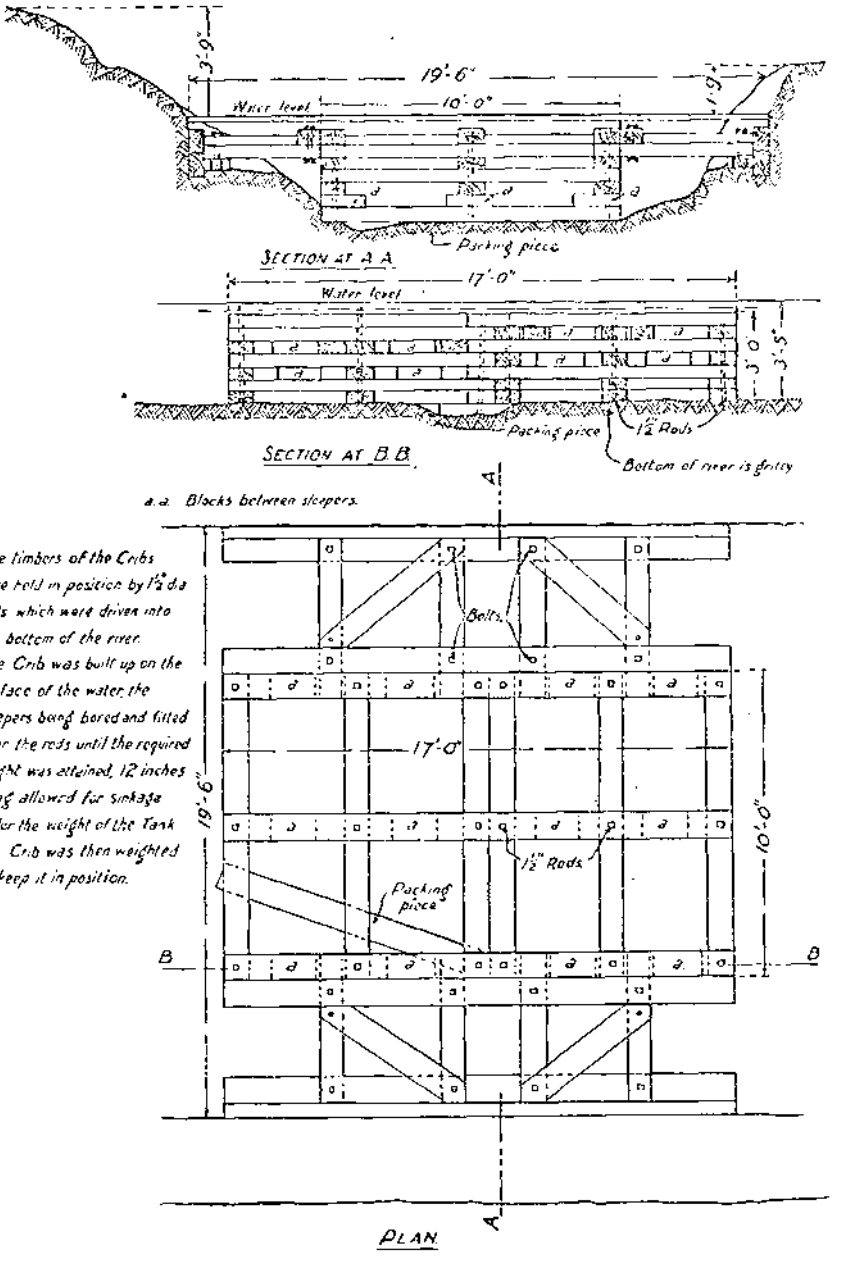
PLAN OF TIMBER TRESTLE BRIDGE AT TRITH ST LEGER.

NOV. 2–4, 1918.



CRIB TANK CROSSING OVER RIVER SELLE.

BUILT OF RAILWAY SLEEPERS.



The timbers of the Cribs were held in position by 1½" dia rods which were driven into the bottom of the river. The Crib was built up on the surface of the water, the sleepers being bored and fitted over the rods until the required height was attained, 12 inches being allowed for sinkage under the weight of the Tank. The Crib was then weighted to keep it in position.

Photograph LIII.

Photograph LIV.

PICTURE

Photograph LV.

Photograph LVI.

PICTURE

Photograph LVII.

Photograph LVIII.

PHOTOGRAPH

Photograph LIX.

PHOTOGRAPH

ORGANISATION OF ENGINEER INTELLIGENCE AND INFORMATION.

PART III., SECTION II.

Introduction.—Engineer Information with regard to the Theatre of War.—Collection and Circulation of Information on Field Engineering in our own and Allied Armies.—Collection and Compilations of material for Stationery Services Publications.—Examination and Circulation of Information with regard to Enemy Field Engineering Methods.

Appendices. A.—List of Plates of Field-work designs. B.—Engineer-in-Chief's Field-work notes. C.—Classified Index of Mining notes. D.—Engineer-in-Chief's D. and D.P. Publications. E.—Index to Engineer-in-Chief's Circulars (Stores Branch). F.—List of Engineer-in-Chief's "D" Publications. G.—List of German Field-Work Plates.

Introduction.—The work required fell under the following headings:—

(1). Collection of Engineer Information with regard to the Theatre of War.

(2). Collection and circulation of information with regard to new types of Field Defences, Mining, Camp Accessories, Engineer Stores, etc., evolved or suggested in the British Armies, and of notes of experience gained in operations and by experiment by our own Armies or those of our Allies.

(3). Collection and compilation of material for Stationery Services Publications, and keeping these publications up to date.

(4). Examination and circulation of information with regard to enemy Field Engineering methods.

Engineer Information with regard to the Theatre of War.—Very little Engineer information was available when hostilities commenced.

The principal data required are:—

(*a*) Nature and width of Roads, and their state in winter.
(*b*) Sources of road repair material.
(*c*) Dimensions of bridges and their safe loads.
(*d*) Nature of waterways and suitability for floating and pile bridges.
(*e*) Factories, workshops, brickyards and engineering material (particularly timber) available.
(*f*) Water Supply.
(*g*) Gas.
(*h*) Electric power installations and circuits.
(*j*) Telegraph and Telephone systems.

(*k*) Geological conditions as regards surface, mining, minerals, and water supply.
(*l*) Inundations possible.
(*m*) Climatic and weather conditions.
(*n*) Fortresses.

There was no Engineer Staff either in the Intelligence or Fortification and Works Directorate for the special purpose.

A "Military Report on Belgium and the Grand Duchy of Luxemburg," of 78 pages, dated 1906, was issued, but it dealt only in generalities, as will be seen from the following extracts on Roads and Rivers:—

"The main roads in Belgium are either paved or macadamized."
River Meuse.—"Its current is swift in many places, while its depth is sometimes as much as 45 feet."

Five volumes of "Belgium Road, River and Billeting Reports" were available on disembarkation. They gave in the itineraries the nature and width of the Roads; the length and width of Bridges, but not the spans, safe loads, or size of the piers; water supply in general terms, "mostly wells and pumps," "well supply," "stand pipes in . . . . ."; and mentioned when there were telegraph lines alongside a road.

The information was in a particularly cumbrous form and could have been grasped much more quickly had it been given on maps.

No Engineer information about N.E. France was available.

The French were somewhat better provided with information, and eventually furnished us with a very limited number of copies of small hand-books called "Notice descriptive et statistique."

Each volume of this series dealt with a department of France or Province of Belgium or Germany. None, however, was of recent date, and beyond short descriptions of bridges (*e.g.*, "masonry abutments, roadway of timber on steel beams, one span 6.m., length 7.50 m., width 2.50 m."), details of Railways and Canals, number of wells, list of factories, contained little Engineer information.

These books, however, formed the foundation of our information.

(The "Report on Western Belgium and adjoining portions of France," issued by the War Office in May, 1916, was almost entirely derived from them. A "Report on Eastern Belgium" was never issued).

The data in these "Notices" were gradually supplemented by what could be obtained from officers of the French and Belgian Ponts et Chaussées, refugees, etc.

An appeal to the Staff of General Foch, who was at Cassel, when the British Army moved to Flanders in 1914, showed that the French General Staff had little Engineer information about their own Country.

A visit to the Ministère de Guerre, Paris, revealed that there was nothing there except of historical value. (An enquiry there for information about the Lille Forts led to original documents signed by Vauban being exhibited).

The Headquarters of the First Army Corps (at Lille before the war), should have had the information, but such documents as it possessed were apparently left in Lille).

Officers who had served in the North of France when referred to, could give very little technical information.

Belgian Officers of Engineers, on the other hand, gave what proved accurate information of their country.

So little was recorded by the French Staff that the Canal-du-Nord was not shown on any Staff Map or referred to in any Military Publication.

Engineer information was first dealt with in the Engineer-in-Chief's office.

Pamphlets and Maps giving details of roads and bridges (Road and Bridge Books), and compilations on water supply, inundations and enemy fortresses were prepared.

In the compilation of Road and Bridge Books much help was got from the Belgian Ponts et Chaussées Officials at Ypres, and from whom a number of " Cahirs de Charge " (Bills of quantities for road and bridge maintenance contracts) were obtained and proved invaluable.

A great part of this particular information was collated by two Belgian Officials of the Ponts et Chaussées, specially attached to the Engineer-in-Chief's Office during most of the War.

Very great assistance was also got from a Belgian officer who had made a hobby for many years of touring the waterways in motor launches, and had picked up an extraordinary knowledge of the details of canals, waterways and bridges.

A good deal of information was also collected from picture post-cards obtained by advertisement and other means.

In March, 1916, it was decided that the work would be done by the Intelligence Department of the General Staff, to whom it was consequently transferred. This department had so much other work to do, that they had little time for Engineer Information, very little of which was contained in such Intelligence Publications as were issued from time to time with regard to the country in front.

The Engineer-in-Chief eventually continued as before to supply G.S. (O), Q.M.G., and Armies direct with information as to inundations, water supply, road metal, geological conditions on front as regards construction of dug-outs, electric power facilities, etc.

All information collected with regard to fortresses was passed to " I."

On a change of establishment in 1918, the Intelligence Section dealing with Engineer Information was, on the advice of the Engineer-

in-Chief, reinforced by two R.E. Officers, and a definite arrangement made that the Engineer-in-Chief's specialists in geology, water supply, electricity, machinery, bridging, roads, inundations, etc., should compile what was required for "I" publications.

It was arranged that all communications with "I" should pass through one officer of the Engineer-in-Chief's Staff to ensure that information obtained by "I" was passed to the Officers concerned and that there was supervision of all intelligence work that left Engineer-in-Chief.

It was also arranged that when refugees and prisoners with technical information were examined an Engineer Officer should assist, for many opportunities for obtaining valuable information may be lost when non-technical Officers carry out interrogations of specialists.

A pamphlet compiled under the final system, "Notes on the Country East of Roubaix," was produced. The Note on Water Supply, and the Appendix on "Possible Inundations in the Schelde Valley," were compiled in the Engineer-in-Chief's Office.

Maps showing where road metal could be found, and nature of the bridges were issued separately.

It was not until the area was reached that information as to electric power installations was obtained.

The final system proved in every way satisfactory. "I" and the Engineer-in-Chief must work together in the matter, and it is convenient that each office should have one Officer told off who acts as the channel of communication with the other.

Even when a complete account of a Country is recorded in peace time, changes take place in war :—Bridges are destroyed, renewed or doubled, new roads, etc., are made. "I" alone has the machinery for getting news of this. Specialists must be employed to compile the technical information.

There would not be full time occupation for them in "I," and it seems in every way suitable to employ those working under the Engineer-in-Chief.

Part of the technical information, *e.g.*, *re* roads, water, etc., is required by Staffs of Formations and not by the R.E. alone, and is best issued by "I" to prevent overlapping.

Other information, *e.g.*, with regard to road metal, electrical circuits, loads, is only required by the R.E., but it is best to issue it through "I," or, at any rate, to consult "I" before issue.

The Intelligence Department was not responsible for Engineer Information with regard to country, except what was behind the enemy's line ; for that behind our own front the E.-in-C. was expected to arrange, but had no special staff for the purpose. A commencement was made at collecting this, but was interrupted by the retirement in March, 1918.

Some definite machinery is required for it, as the dimensions of the Bridges and nature and widths of Roads, sufficiency or otherwise of the number of Roads and Bridges, areas suitable for dug-outs, areas it was possible to inundate, were not recorded when required in the Spring of 1918, and reconnaisances had to be hurriedly carried out.

Collection and Circulation of Information on Field Engineering in our own and Allied Armies.—Such information on Field Engineering as it was considered desirable to circulate was originally issued in "Notes from the Front," collated by the General Staff, and "Notes on Field Defences," 1914.

It was not until early in 1916 that a regular series of R.E. Publications took form. These were :—

(*a*) E.-in-C. Plates of Field Work Designs (Appendix A.)
(*b*) E.-in-C. Field Work Notes (Appendix B.)
(*c*) Mining Notes (Appendix C.)
(*d*) D.P. series of Plates of huts or other Camp accessories (Appendix D.)
(*e*) E.-in-C. Circulars, Stores Branch (Appendix E.)
(*f*) Standard Bridge Drawings.
(*g*) Drawings and descriptions of articles made in R.E. Workshops.

Lists of these Plates and Notes are attached, with the exception of (*f*) and (*g*), details of which will be found in the Sections dealing with Bridging, and Workshops respectively.

Short notes of ephemeral interest, and small matters which it was desired to bring to the attention of C.E.'s, but which were not of sufficient importance to circulate generally, were also issued as Series "D" (Appendix F.) The use of this Series was not consistent, but it is certainly of advantage to deal with such matters in a continuous series, kept together for reference, rather than to issue them under unconsecutive numbers of a Central Registry.

The material for the above plates and notes was obtained by contributions from formations and units, visits of Liaison Officers, calling for reports on special subjects (*e.g.*, the effect of shell-fire on concrete structures), experiments conducted at G.H.Q., the R.E. Training School, Rouen, Mine Schools, etc.

Selection, compilation, editing and publication were dealt with by the three sections of the Engineer-in-Chief's Office—Defences, Mining, and Stores, until 1918, when it was arranged that all publications should pass through the hands of one Officer before issue.

The method of issue was as a rule that the proofs of plates and notes were sent to the Chief Engineer of each Army, who then said how many copies he required, and thus controlled the issue in his Army.

500 copies of each publication were eventually, by request, sent to the War Office for issue to home and to other Expeditionary Forces

The Engineer-in-Chief ordered the number of copies required and issue was made direct from his Office.

It would seem advantageous that in future an Engineer-in-Chief's Office should have a section for publication and issue of information.

Summaries were issued of the French Secret Publication, "Bulletin de Renseignements du Génie," containing much valuable information, of which eight Volumes were issued, and also of the Official French Publications :—

"Instruction sur les travaux de Campagne," December, 1915.
"Instruction sur l'organisation du Terrain," Parts I. and II., 1917.
"Instruction sur l'organisation et la Construction des batteries." 1917.
"Ecole des Mines." 1914 (Elementary).
"Ecole des Mines" (Livre de l'Officier), 1914 (Advanced), with Supplement, 1917.

The Russian and Italian Official Publications were examined, but as they contained no new or novel matter, nothing with regard to them was issued.

The American publications, being derived mainly from British ones, it was unnecessary to bring to general notice.

The form they were issued in—loose leaved, 6 in. × 3½ in., with round edges—was very convenient.

Stationery Services Publications.—The first general pamphlet on Field Engineering was "Notes for Infantry Officers on Trench Warfare," March, 1916.

This was prepared without reference to the Engineer-in-Chief, although a few diagrams issued by him were included in it.

Subsequently all Publications on Engineer matters were prepared in the Engineer-in-Chief's Office.

A revised set of diagrams for the above pamphlet was issued in December, 1916. This was superseded by S.S. 196, "Diagrams of Field Defences," March, 1918

Other S.S. publications of engineer interest were :—

S.S. 145 "Notes on R.E. Preparations for, and the employment of the R.E. in Offensive Operations," revised in January, 1918, as "Notes on Engineer Work during Operations."

Founded first on the experience of 1915 at Neuve Chapelle and Loos, it was entirely re-written after the Battle of the Somme, and largely added to after Vimy and Messines, in 1917.

S.S. 208. "Field-works for Royal Artillery."
S.S. 220. "Field-works for Pioneer Battalions."
S.S. 202. "Organisation of Shell Hole Defences."
S.S. 177. "Instructions on Wiring" (Rapid Wiring).
S.S. 108. "Notes for C.R.E.'s on Organisation of R.E. Work when holding a line." March, 1916.
S.S. 104. Précis of Divisional R.E. Instructions to a Division about to take over a line." March, 1916.
S.S. 112. "Consolidation of Trenches, localities and craters after assault and capture." May, 1916.
S.S. 219. "Notes on Road Building."
S.S. 116 "Notes on cover against Shell-fire" (Revised, December, 1916).
S.S. 182. "Instructions on Bombing" Part I. (British and German Bombs).
S.S. 206. "The Principles and Practice of Camouflage."
S.S. 180. "Notes on Screens."
S.S. 115. "Notes on Mining" (translated from the French).

S.S. 135 "The Division in Attack" (Revised Edition, November, 1918), and S.S. 210, "The Division in Defence," May, 1918, contain valuable instructions as to the employment of the R.E.

After each pamphlet was issued arrangements were made for an Officer to take charge of it and collect materials for a revised Edition as they came to notice.

The experiment of bringing in special Officers into the Engineer-in-Chief's office to compile pamphlets was not altogether a success.

It was found preferable and more expeditious for Officers trained in compiling to put the material available together and then to submit the MS. for examination to one or more C.E.'s or C.R.E.'s as seemed desirable, for criticism and advice.

Examination and Circulation of Information with regard to Enemy Field Engineering Methods.—This was done in conjunction with G.S., Intelligence.

All information obtained by "I" was sent over to Engineer-in-Chief for examination and recommendation as to whether it should be issued to the Armies or not; information obtained by Engineer-in-Chief from Engineer sources was similarly treated.

Matters of immediate importance, *e.g.*, enemy traps, grenades, were prepared for reproduction and handed to "I" for issue in the "Ia" series; others were prepared for publication in the series "German Field Work Plates" (Appendix G.)

Engineer-in-Chief also undertook the revision of "I" translations on Field Engineering. The most important was:—"Stellungsbau" (the Construction of Field Positions), with the four Editions of the

"Introduction," laying down the general principles of the use of field defences.

As time went on and the mass of information about the Country ahead increased, and the Staff of the Engineer-in-Chief's Office changed (in November, 1918, there was only one Officer and one Clerk who were in the Engineer-in-Chief's Office in November, 1914), it was found necessary to appoint an Officer to index and take charge of all information, records, books and maps, so that if anything was wanted it could be readily found. Unless this is done, information is apt to get lost sight of, not only at G.H.Q., but by fighting formations, which it was necessary to remind. The Officer combined this work with charge of the draughtsmen's office.

Thus three Officers were eventually required to deal with information; and one to do liaison with "I"; one to deal with the issue of Publications, and one to take charge of records.

Reproduction of Engineer Publications was undertaken and done most expeditiously by the Army Printing and Stationery Services in the Field; very urgent work was done by the Printing Section of the Field Survey Depôt Battalion, G.H.Q.

APPENDIX A.

LIST OF PLATES OF FIELDWORK DESIGNS.

Issued under E.-in-C., Nos. $\frac{\text{FF}}{1 \text{ to } 146}$

No. 1. Elliptical Concrete Dug-out (for water-logged clay). (Cavalry Corps.)
,, 2. Brick Tower Artillery O.P.
† ,, 3. Light Canvas Collapsible Gabion (*Fig.* 17.)
‡ ,, 4. Trench Frames. Do. do.
† ,, 5. Collapsible Knife Rest with angle iron ends. (First Army.) (*Fig.* 34.)
† ,, 6. Collapsible Wire Netting Gabion. (French.) (*Fig.* 17.)
,, 7. German Front Trench System with keep and bomb stops.
,, 8. Keep and Bomb Stop. (Third Army Infantry School.)
,, 9. Bomb Stops. Do. do.
,, 10. Sentry Post. (1st Division.)
,, 11. Ryes O.P. Plate with specimens of its use.
,, 12. Artillery Shelters. (I. Corps.) 18-pdr.
,, 13. Do. 60-pdr. (*See* No. 27.)
,, 14. Concrete M.G. Emplacement. (I. Corps.)
‡ ,, 15. Deep Dug-outs. (1st Division.)
† ,, 16. Shelter made with ½-in. "Elephant" sheets. (*Fig.* 68.)
† ,, 17. Small C.I. Shelter. (*Fig.* 67.)
‡ ,, 18. Entrance to Deep Dug-out.

No. 19. Double Roof Timber Shelter for 18-pdr. (VII. Corps.)
‡ ,, 20. Deep Dug-out. (IV. Corps.)
‡ ,, 21. Do. Entrance. (IV. Corps.)
,, 22. 2-in. T.M. Emplacement. (First Army.)
,, 23. Shelter for 4·5-in. Howitzer. (153rd Field Co. R.E.)
,, 24. 9·45-in. T.M. Emplacement. (II. Corps.)
† ,, 25. M.G. Emplacements and Dug-outs. (IV. Corps.) (*Fig.* 51.)
,, 26. M.G. Emplacement in Breastwork. (2nd Field Co., R.E.)
,, 27. Shelter for 60-pdr. (I. Corps.) (*See* No. 13.)
† ,, 28. Mock Sandbag O.P. (*Fig.* 69.)
,, 29. Baby "Elephant" Dug-out. (55th Division.)
,, 30. Dressing Station, 15th Division.
† ,, 31. Concertina Barbed Wire. (First Army.) (*Fig.* 35.)
,, 32. Do. do. (Second Army.)
,, 33. Concrete O.P. Tower. (XIV. Corps.)
,, 34. Concealed M.G. Emplacement with counter weight roof. (Captain Foot, R.E.)
,, 35. Giant Disappearing Periscope. (2/2nd West Lancs. Field Co., R.E.)
,, 36. Four Hours Covered M.G. Emplacement. (121st Field Co., R.E.)
,, 37. Blocking Gate. (Second Army.)
† ,, 38. Parapet Hurdle made of cement cask. (25th Army Troops Co.) (*Fig.* 14.)
† ,, 39. Typical Deep Dug-out. (Third Army.) (*Fig.* 61.)
† ,, 40. Lookout Box for O.P. with sliding steel plates. (*Fig.* 69.)
† ,, 41. Improvised Water Level. (Third Army.) (*Fig.* 41.)
† ,, 42. Deep Dug-out near front line with emergency exit. (*Fig.* 64.)
,, 43. 9·45-in. T.M. Emplacement. (Fourth Army). (A.A's. pattern.)
† ,, 44. Shielded Sniper's Post. (First Army.) (*Fig.* 71.)
,, 45. Concertina Barbed Wire. (3rd Aust. Division.)
† ,, 46. Sniper's Loophole and Post. (2nd Division.) (*Fig.* 72.)
,, 47. Field Dressing Station. (61st Division.)
,, 48. Do. do. do.
† ,, 49. Splinter and Bullet Proof Sentry Post. (154th Field Co.) (*Fig.* 70.)
,, 50. Harwood EXPM Revetting Hurdle. (2nd Division)
,, 51. Aid Post Sorting Station. (32nd Division.)
,, 52. Field Magazine. (32nd Division.)
,, 53. S.A.A. Magazine. (32nd Division.)
,, 54. Latrine. (1st Australian Division.)
‡ ,, 55. Trench Revetting Truss. (32nd Division.)
† ,, 56. Communication Trench Defences, Dog Legs, Loop-holed Traverses. (32nd Division.) (*Fig.* 37.)
† ,, 57. Armoured Sentry Box. (32nd Division.) (*Fig.* 73.)
,, 58. Design for Dug-out under parapet with covered Sentry Posts. (VII. Corps.)

No.	59.	Shell-proof Dug-out. (I. Anzac Corps.)	
,,	60.	Shell-proof Dug-out (I. Anzac Corps), in low-lying water-logged areas.	
,,	61.	Candle Lantern made from Biscuit tin. (25th A.T. Co.)	
,,	62.	Dimensions of Gun Emplacements. (Artillery Adviser, G.H.Q.)	
,,	63.	Cruciform Post. (III. Corps.) (*See* Fieldwork Notes No. 13.)	
,,	64.	Type of Dug-out. (1st Division.)	
,,	65.	Double Spiral Staircase for Entrance to Deep Dug-outs. (New Zealand Division.)	11 - 16.
,,	66.	Portable Revetment Frame. (105th Infantry Bde.)	11 - 16.
‡ ,,	67.	Cruciform Strongpoint for a Platoon. (56th Divnl. Engineers.) (*See* Fieldwork Notes No. 13.)	10 - 16.
,,	68.	Bomb Post Block for Communication Trench behind Front Line. (46th Division.)	
,,	69.	Deep Dug-outs, examples of recent practice.	12 - 16.
,,	70.	Mined Passages to Deep Dug-outs.	12 - 16.
,,	71.	Dimensions of Gun Emplacements. (18-pdr. and 4·5 Howitzer.)	1 - 17.
,,	72.	Light Railway Trolley. (32nd Division.)	12 - 16.
,,	73.	Bomber's Pit. (8th Division).	12 - 16.
,,	74.	Mud Toboggan. (32nd Division.)	12 - 16.
,,	75.	Speaking Tube Fittings. (First Army Workshops.)	1 - 17.
,,	76.	Concealed Machine Gun Emplacement—Imitation Shell Hole. (170th Co., R.E.)	1 - 17.
,,	77.	Sniper's Post. (First Army Workshops.) Double Framework.	1 - 17.
,,	78.	Defence of Infantry Subways. (Limited Issue.)	1 - 17.
,,	79.	Field Periscope.	1 - 17.
,,	80.	Portable Bunk. (Third Army.)	1 - 17.
‡ ,,	81.	Standard Trench Frames. (*See* Fieldwork Notes No. 23.)	1 - 17.
,,	82.	Notes on Types of Dug-outs in use in Second Army.	2 - 17.
,,	83.	Device for Lacing together X.P.M. sheets in Revetments. (1/3rd Kent Field Co., R.E.)	2 - 17.
,,	84.	Underground Cookhouse. (35th Division.)	1 - 17.
,,	85.	Gate and Frame for flank defence of front line posts. (126th Field Co., R.E.)	2 - 17.
,,	86.	Baby "Elephant" Shelter, with bursting course on frames. (II. A.N.Z.A.C.)	2 - 17.
,,	87.	Whittall's Stokes Gun Emplacement. (16th Division.)	4 - 17.
,,	88.	Short Revetting Frames. (Second Army pattern.)	5 - 17.
,,	89.	Cover for Heavy or Medium Trench Mortar Emplacement. (Third Army School of Mortars.)	6 - 17.
,,	90.	Subways:—Typical Arrangement of Galleries and Accessory Dug-outs.	6 - 17.
,,	91.	Carey's Water Carrier for Pack Mules. (4th Canadian Division.)	3 - 17.
,,	92.	Observation Post. (29th Division.)	8 - 17.
,,	93.	Improvised Pack Saddlery. (430th Field Co., R.E.)	8 - 17.
,,	94.	Shell Slit for Protection of two or three men guarding entrance of Dug-out. (III. Corps.)	7 - 17.

No. 95.	Heavy Trench Mortar Emplacement. (3rd Aust. Tunnelling Co.)	8 - 17.
,, 96.	Dug-out Entrance. (251st Co., R.E.)	8 - 17.
,, 97.	Tank Causeway. (184th Tunnelling Co., R.E.)	8 - 17.
,, 98.	Jump Crossing for Tanks. (184th Tunnelling Co., R.E.)	8 - 17.
,, 99.	Pack Saddle Attachment for carrying barbed wire or long screw pickets. (61st Division.)	9 - 17.
,, 100.	Ambulance Bogey. (XIV. Corps Troops.)	8 - 17.
,, 101.	Pontoon. (Petrol Tin Floats). (XIV. Corps Troops.)	8 - 17.
,, 102.	Decks. (Petrol Tin Floats). (XIV. Corps Troops.)	8 - 17.
,, 103.	Plan and Details shewing connection of Decks to Floats and Shore. (XIV. Corps Troops.)	8 - 17.
,, 104.	Water Barrel Bogey. (XIV. Corps Troops.)	8 - 17.
,, 105.	Well Head Windlass and Frame. (XIV. Corps Troops.)	8 - 17.
,, 106.	Hut Shelter. (III. Corps.)	6 - 17.
,, 107.	Hut Shelter, High Sides. (III. Corps.)	11 - 16.
,, 108.	Incinerator of Angle Iron and small steel shelter. (III. Corps.)	6 - 17.
,, 109.	Reinforced Concrete Horse Trough. (148th A.T. Co.)	7 - 17.
,, 110.	Entrance Frame.	10 - 17.
,, 111.	Screen for Water Tank. (148th A.T. Co.)	7 - 17.
,, 112.	'Y' Frame for repair of trenches.	17.
,, 113.	M.G. Emplacement (Champagne type). (With inclined shaft to dug-out).	9 - 17.
,, 114.	M.G. Emplacement (Champagne type). (With vertical shaft to dug-out).	9 - 17.
,, 115.	Medium Trench Mortar Emplacement. (Embrasure in the communication trench).	9 - 17.
,, 116.	Medium Trench Mortar Emplacement. (Embrasure disguised as a shell hole).	9 - 17.
,, 117.	Ferret Bomb.	10 - 17.
,, 118.	Machine Gun Emplacement. (Champagne Type). (Cancels FF/113 and FF/114).	11 - 17.
,, 119.	Expanded Metal Revetting Hurdle.	11 - 17.
,, 120.	Gas Blanket arrangement under various conditions.	12 - 17.
,, 121.	French Wire—New method of preparing coils for carrying.	12 - 17.
,, 122.	Cable throwing from Livens Projectors.	11 - 17.
,, 123.	Sandbag Filler.	
,, 124.	H.T.M. Emplacement and Ammunition Chamber.	1 - 18.
,, 125.	Method of Breaking-away Chambers from a Dug-out Gallery.	1 - 18.
,, 126.	Camouflage Cover for M.G. Emplacement.	
,, 127.	Gas Protector Frames.	1 - 18.
,, 128.	Instructions for Repair of Old and Impassable Trenches.	2 - 18.
,, 129.	Field Gun Emplacement to give All Round Fire.	2 - 18.
,, 130.	Light Bridge for Raiding.	2 - 18.
,, 131.	8-inch Proof Shaft Dug-out.	- 18.
,, 132.	Destruction of a Concrete O.P. by Guncotton.	3 - 18.
,, 133.	(I). Tank Ditch. (II). Dug-out Entrance.	5 - 18.

No. 134.	Machine Gun Platform Table.	1s.
,, 135.	Type Plan of M.G. Position for 4 Guns.	5 - 1s.
,, 136.	Spider Wire Entanglement	1s.
,, 137.	Machine Gun Emplacement (Champagne Type) (Cancels FF/118).	1s.
,, 138.	Machine Gun Emplacement with "Longfield" Trch. Mtg.	6 - 1s.
,, 139.	Cork Bridge Piers.	6 - 1s.
,, 140.	Instructions for the erection of the Moir Pill Box.	8 - 1s.
,, 141.	O.P. in Building, using Rye's Plates.	8 - 1s.
,, 142.	Provisional instructions for the erection of Hobbs' Pill Box)	9 - 1s.
,, 143.	Reinforced Concrete Shelter.	1s.
,, 144.	Reinforced Concrete "Pancake" Shelter.	1s.
,, 145.	Protection of Shelters against Direct Hits from Bombs.	11 - 1s.
,, 146.	Floating Bridge for Infantry in File.	1s.

NOTES.—†Reproduced in "Revised Diagrams, December, 1916," of "Notes of Trench Warfare for Infantry Officers;" the number of the Figure given in brackets after the title is the reference to this publication.
‡Superseded by later patterns.

APPENDIX B.

ENGINEER-IN-CHIEF'S FIELDWORK NOTES.

No.	SUBJECT.
1.	Defence of Communication Trench.
2.	Saps to Craters, with Bombers' Pits.
3.	Back Entrances to Deep Dug-outs and Concealment of T.M. Emplacements.
4.	Reclamation of Trenches; Concealment of Work; German Cover against Shell Fire.
5.	Protection of Entrances of Deep Dug-outs from Flooding.
6.	Report on Experiments and Experience with Torpedoes and Pipe Forcing Jacks for Clearing Gaps through Barbed Wire Entanglements.
7.	German Concrete Construction, Rusty Wire, Shelters to L. Trenches.
8.	Concealment, Notes on recent Operations.
9.	Underground Galleries under No Man's Land. Notes on Recent Operations. Enemy Defences.
10.	Extracts from Reports on the Somme Operations.
11.	Use of Pipe Pusher and Wombat Boring Machine, Hits by German Heavy Minenwerfer.
12.	Timber and Canvas Plate Girder Bridge. (No copies available).
13.	Strong points.
14.	Extracts from Reports on the Somme Operations.
15.	Cut and Cover Trenches for Light Railways.
16.	Extracts from Reports on the Somme Operations.
17.	Mined Dug-out Construction.
18.	Arrangements for Indirect Machine Gun Fire.
19.	Pontoon Bridge for Lorry Traffic.

No.
20. German Traps.
21. Bangalore Torpedoes.
22. Forward Tramlines in Trench Warfare.
23. Deep Revetting Frames.
24. Timber Plate Girder Bridge.
25. Effect of Mobile Charges on Dug-outs.
26. Infantry Sub-ways.
27. Enemy Mines and Demolitions.
28. Temporary Road Bridge Constructed by 62nd Divisional Engineers over a Flooded Area.
29. Cover from Shell Fire :—Précis of Results of Experimental Firing with 5·9-in. Shells carried out by Belgian Army, February and March, 1917.
30. Pontoon Bridges for Motor Transport.
31. German Concrete Structures on Messines Ridge and the Effect of Shell Fire on them.
32. Concealment of Isolated Machine Gun Positions and Emplacements.
33. Extracts from Reports by Chief Engineers and C.R.E.'s who took part in the Operations of the Second Army at Messines Ridge.
34. Notes on Construction of Trench Tramways during Messines Operations.
35. Extracts from Reports of Chief Engineers and C.R.E.'s on Recent Operations (excluding those of Second Army) and from Suggestions for a New Edition of S.S.145, "Notes on R.E. Preparations for, and the Employment of the R.E. in Offensive Operations."
36. Improvised Torpedo for Wire Cutting left behind by the Germans on the Occasion of a Recent Raid. (C.R.E., 35th Division, 22.7.17).
37. Notes on Forward Road Construction.
38. Use of Thermit to Render Guns Temporarily Unserviceable.
39. Experimental Tests of Types of Revetment.
40. Destruction of German Explosives.
41. Type of Rapid Shelter.
42. Example of Rapid Construction of a Ferro-concrete Shelter, etc.
43. German Concrete Structures in the area North of Ypres Captured in August, 1917, and the Effect of Shell Fire on them.
44. Temporary Patching of Berthon Boats, etc., etc.
45. Instructions for Construction of Trenches and Repairs of Trenches.
46. Effect of Bombing on Dug-outs.
47. Report on Test of Reinforced Concrete Machine-gun Emplacement at Kemmel.
48. Use of Ferro-concrete in Dug-out Construction.
49. Demolition of a Tank.
50. Notes on Road Construction.
51. Demolition of Derelict Tanks.
52. Road Craters.
53. Notes on Demolitions.
54. Abbreviated Translation of French Pamphlet on Engineer Stores.
55. Notes on Demolitions. (Addendum to E-in-C. Fldwk. Note No. 53).
55. Concrete Block Shelters.
57. Well Demolitions.

No.
58. Collapsible Boats.
59. German Traps and Mines.
60. Firing Demolition Charges with Cordeau Detonant.
61. Firing Demolition Charges Electrically with Torch Batteries (A.O.D. Supply).
62. Dummy Trenches.
63. Experiment to test the best form of Junction Box for Instantaneous and Safety Fuze.
64. Deliberate Demolitions.

APPENDIX C.

CLASSIFIED INDEX OF MINING NOTES.

(Nos. 1 to 100.)

APPENDIX D.

ENGINEER-IN-CHIEF, D. & D.P. PUBLICATIONS.

D/37.	Rifle Range Target Frame.
D/62.	Oil Drum Stove.
D/64/1.2.	River Scheldt.
D/75/1.2.3.	Details of Woodwork, VII. Corps Hut.
D/110.	Down draught Stove (Canadian pattern).
D/115.	"Wilson" Trench Monorail.
D/123.	Improvised Stoves.
D/124.	Field Cooker.
D/125.	Oven.
D/131.	Improvised Incinerator.
D/133.	River Dendre Sections.
D/135.	Portable Hut.
D/145.	Shelf and Brackets, Nissen Bow Huts.
D/146.	Nissen Bow Huts, Packing of Parts.
D/148.	Corrugated Steel Shelter, English Pattern.
D/154.	Heating Apparatus: Drying Room.
D/155.	Reservoir to hold 50,000 galls.
D/162.	Canadian Pattern Stove, Small size.
D/166.	Semi-Portable Stove.
D/174.	Bayonet Fighting Gallows.
D/179.	Artillery Bridge, Second Army, "A" type.
D/163.	Electrical Fittings.

D/186. Shower Baths, Arrangement and Details of.
D/210. Corrugated Steel Shelter, English.
D/211. Do. Small.
D/226. Sectional Canvas Troughing.
D/230. Nissen down draught Incinerator.
D/233. Latrines.
D/240. Belt Pumps.
D/251. Axle Wheels and Axle Box.
D/256. Roofing for Stables and Shelters.
DP/272. Tarrant "Dechets" Hut.
DP/273. Sommerville Portable Hut.
DP/277. Details of Flap Bridge.
DP/278. R.E. Stove, Type A.
DP/279. Do. Type B.
DP/280. Do. No. 2.
DP/281. Do. No. 3.
DP/293. Constructional Drawing, Sergeants' Mess.
DP/294. Do. Officers' Mess.
DP/295. Type of Camp Buildings.
DP/296. Company Cooking Shelter.
DP/297. Dining Room, 100 ft. × 28 ft.
DP/298. Bath House for 1,000 men.
DP/299. Buildings for C.C.S.
DP/300. Shower Bath and Disinfector Shed, C.C.S.
DP/301. Drying Room for 1,000 men.
DP/302. Drying Room.
DP/303. Drying Rooms.
DP/304. Roofing and Horse Shelters for Field use.
DP/305. Tarrant Huts for C.C.S., 200 beds.
DP/306. Accommodation in camp.
DP/321. Nissen Bow Hut.
DP/323. Roofing for Ammunition Dumps.
DP/330. Nissen Hospital Hut.
DP/339. Kitchen and Ovens, No. 9 C.C.S.
DP/346. 4 in. Plug Valve for Outlets in Reservoir.
DP/347. Roofing for Ammunition Dumps, Mark II.
DP/365. 2 Berthon Boats to form Raft.
DP/396. Tarrant Portable Hut, Mk. II.
DP/414. Light Shedding for Workshops and Stores.
DP/421. Water Cart Filling Points.
DP/480. Water Bottle Filler.
DP/485. Tank Cover.
DP/602. Light Portable Buildings.
DP/603. Moir Pill Box.
DP/606. Semi-Portable Stove.
DP/608. Details of Table and Form.
DP/611. Squatter Latrine.
DP/612. Portable Latrine.
DP/613. Do.
DP/614. Do.
DP/615. Ablution Bench.
DP/616. Timber Framing for Tarpaulin Shelter.
DP/618. Trench Bridges.
DP/625. C.I. Bivouac Shelters.
DP/626. 15 ft. Infantry Bridge.

DP/635.	Corrugated Iron Culvert.
DP/648.	Aston Demontable Hut.
DP/649.	Design for 6 spray bath.
DP/642.	Standard Mining Frames.
DP/663.	Orr Disinfector.
DP/801.	Nissen Huts: Hook bolts.
DP/816.	Portable Frame for Canvas Water Tanks.
DP/819.	Bath House, of light shedding.
DP/820.	Nissen Shower Baths.
DP/823.	C.C.S., Fifth Army.
DP/825/A.B.	Sausage Hutting.
DP/826/A.B.C.D.	Do. for C.C.S.
DP/828.	Brick or Concrete Hut for 44 men.
DP/829.	Sheet Iron Horse Trough.
DP/832.	Stretcher Frames.
D.1.	Cordite Fumes in covered M.G. Emplacements.
D.2.	Method of Destruction of Dug-outs.
D.3.	Results of Direct Hits on Gun Pits.
D.4.	Failure of Detonators and G.C. Primers.
D.5.	Salvage of Barbed Wire.
D.7.	Blowing Inclined Shafts.
D.8.	Footbridge.

APPENDIX E.

INDEX TO E-IN-C'S CIRCULARS (STORES BRANCH).

No.	Subject.
1.	Compressed Air Pumping Plant (at W.22.A.8.0.).
2.	Disposal of Foul Water in Camps.
3.	Canvas Water Elevator Pamphlet.
4.	,, ,, ,, Sketch.
5.	Graph for Water Supply for Horses.
6.	Hasty Method of Repairing Water Main.
7.	Shipping Lists. Nissen Hospital Huts.
8.	Notes on the Operation of Corrugated Steel Bending Rollers.
9.	Quantities and Specifications for Nissen Bow Type Hospital 60 ft. × 20 ft.
10.	Water Boring Forms.
11.	Inglis Heavy Type Bridge. Safe Loads.
12.	,, Light ,, ,, ,, ,,
13.	Property Distribution Return.
14.	Arrangement for Filling Water Bottles, etc.
15.	Organization of R.E. Stores.
16.	Instructions for Working Tar Spraying Machines.
18.	Petter Engines.
19.	L.C.C. Fire Returns.
20.	Wooden Roller for Bending C.I.
21.	Report on Decauville Trucks.
22.	Notes on Possibilities of obtaining Road Metal in area Gommecourt-Cambrai-St. Quentin-Bray sur Somme.
22a	Notes on Geology.
23.	Horse Troughs.

No. Subject.

24. Inglis Type Bridges. Description.
25. Nissen Hut. (Second Revised Specification).
26. Notes on Winter Accommodation.
27. Shipping Lists. Woodwork for Nissen Bow Hut.
28. Road Repairs.
29. Inspection of R.E. Workshops.
30. List of Current Prices (27.10.15) for Timber, Iron and Steel Work.
31. Pipe Laying.
32. Duty of L.C.C. Fire Engines.
33. Instructions for the Administration of R.E. Works in the Field.
34. Notes on Laundries.
35. List of Current Prices (November, 1916) for Timber, Iron and Steel Work.
36. Packing Instructions Steelwork Nissen Hospital Huts.
37. Armies Stocks, January, 1917. A.O.D. & R.E. Stores.
38. Moir Pill Boxes. Instructions for Erection.
39. Taking over from French, Forms.
40. R.E. Stocktaking Sheets and Circular Letter (*See* 41 for Summary of Results).
41. Notes on Field Water Supply Engineering by Fifth Army.
42. Sandbags—Prevention of Fires.
43. Instructions for Tarring Sailcloth Sheets used as Storage Tanks for Water (connects with 46).
44. Nissen Hospital Hut Pamphlet.
45. Notes on 60 c.m. Track.
46. Notes from a Lecture on Water Supply in the Field. (Fifth Army Pamphlet).

APPENDIX F.

LIST OF E.-IN-C. "D." PUBLICATIONS.

D./1 Cordite Fumes in covered M.G. Emplacements.
D./2 Method of Destroying Dug-outs to render them useless to the Enemy.
D./3 Report of Result of Direct Hits on Gun Pits.
D./4 Failure of Detonators and G.C. Primers.
D./5 Salvage of Barbed Wire.
D./6 Method of converting 2 medium screw pickets into one long and one short.
D./7 Blowing Inclined Shafts.

APPENDIX G.

LIST OF GERMAN FIELDWORK PLATES.

No. 1. Entrances to Dug-outs.
„ 2. Company Dressing Station.
„ 3. Brigade Battle Headquarters between Bernafay Wood and Longueval.
„ 4. Tunnelled Dug-outs, Mametz.

No. 5. Lanz T.M. Emplacement and O.P.
„ 6. T.M. Emplacement. General Arrangement.
„ 7. Dug-out with Reinforced Concrete over Entrance.
„ 8. Albrecht Mortar Emplacement.
„ 9. Typical Dug-out (with Bunks off a central passage).
„ 10. Shelters in Breastworks.
„ 11. Medium Minenwerfer Emplacement (General Arrangement).
„ 12. Plates from Hectographed Note-book: Drainage, Breastworks.
„ 13. „ „ „ „ Concrete Shelters.
„ 14. „ „ „ „ M.G. Shelters.
„ 15. Trench O.P.
„ 16. Shelter with "Arresting Course."
„ 17. Diagram of Trench System.
„ 18. Mobile Charges.
„ 19. Concrete M.G. Emplacement.
„ 20. Cover from Shell Fire (extracts from Official Manual: Stellungsbau).
„ 21. Dug-outs in hard and soft soil.
„ 22. Sketch of M.G. Emplacements with Deep Dug-outs.
„ 23. O.Ps. (From Official Manual: Stellungsbau).
„ 24. Brigade Command Post Near Thiepval.
„ 25. Artillery Command H.Qrs. and O.P. (From Official Manual: Stellungbau).
„ 26. Sketches from N.C.O.'s Notebook: Trip Mine, M.G. Emplacement, O.P., Latrine.
„ 27. Concrete M.G. Emplacement with Periscope.
„ 28. Concrete Emplacement "Igel."
„ 29. Concrete O.P.
„ 30. Reinforced Concrete O.P.
„ 31. M.G. Emplacement and Dug-out.
„ 32. Mobile Charge. (64 lbs.).
„ 33. Live Wire Entanglement.
„ 34. Mobile Charge.
„ 35. Land Mine.
„ 36. Section of Trench exposed to Heavy Fire.
„ 37. Command Sentry Post.
„ 38. Concrete M.G. Emplacement.
„ 39. Emplacement for 77 c.m. Guns.
„ 40. Look-out Post in Front Trench.
„ 41. Disappearing M.G. Emplacement.
„ 42. Electrified Entanglement.
„ 43. Trench Block.
„ 44. Machine Gun and Searchlight Emplacement.
„ 45. Emplacement for Albrecht Mortars.
„ 46. Dug-out with Shell Hole Look-outs.
„ 47. Minenwerfer Emplacement and Dug-outs.
„ 48. Plates from Stellungsbau (2nd Edition).
„ 49. Ammunition Shelter and Recess.
„ 50. Gun Battery near Vimy.
„ 51. Gun Emplacements near Liévin.
„ 52. Emplacements built of Concrete Blocks.
„ 53. Armoured Observation Post.
„ 54. Concrete Shelter for Machine Gunners.
„ 55. German Steel O.P.
„ 56. "Holding on" Point.

No. 57. Improvised Emplacement for Trench Mortars.
„ 58. Reinforced Concrete Gun Emplacement.
„ 59. Shellproof Shelter for Men or Ammunition.
„ 60. Shelter under Parapet for eight men.
„ 61. German Observation Post.
„ 62. Blaireville: Enemy Caves and Subways.
„ 63. Concrete Machine Gun Emplacement.
„ 64. Mined Dug-outs near Wytschaete.
„ 65. Type of Concrete Shelter in the Siegfried Line.
„ 66. Concrete Defensible Post (Mebu).
„ 67. Dug-outs and Wire.
„ 68. German Bangalore Torpedoes.
„ 69. Gaps in Wire Entanglements
„ 70. (No. 1) Trace of Trenches. (No. 2) Profile of Trenches. — Hindenburg Line.
„ 71. Hindenburg Line near Croisilles. — Hindenburg Line.
„ 72. Hindenburg Line at Bellicourt. — Hindenburg Line.
„ 73. Wire Entanglements. — Hindenburg Line.
„ 74. Wire Entanglement. — Hindenburg Line.
„ 75. Location of M.G.'s from Form of Wire. — Hindenburg Line.
„ 76. "Mebu." — Hindenburg Line.
„ 77. Concrete Shelters in Hindenburg Line near Heninel. — Hindenburg Line.
„ 78. Anti-Tank Gun Emplacement.
„ 79. German Trench Mortar Emplacements.
„ 80. Hasty Shelters.
„ 81. Deepened Shell Hole Emplacement.
„ 82. Sketches of Shelters and Trenches for use in coming Winter.
„ 83. Fortified Shell Holes.
„ 84. Defensible Concrete Shelter.
„ 85. Trace and Profile of Trenches in front of Havrincourt Village on the Trescault-Havrincourt Road, showing Standard open M.G. Emplacement and 3 ft. Broad Fire Step. — Hindenburg Line.
„ 86. German Observation Post. On Havrincourt-Trescault Road in front of Havrincourt. — Hindenburg Line.
„ A. Diagram showing the Organization of a Company Sector for the Winter Months.
„ 87. German Machine Gun Emplacement and Shelter. (From a French Report. April, 1918).
„ 88. German Spider Web Wire.

[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), and January 1920 (Bridging, Chapter III., *(continued)*, p. 13). Copies of these Journals may be obtained through the usual channels.]

BOOKS ON ELECTRICITY.

THE following is a list of books which are recommended to officers who wish to improve their knowledge in various branches of electricity.

The list is not complete, but will be republished with additions and amendments from time to time.

Should an officer require information on any subject not included in these lists, he should write direct to the Secretary, R.E. Institute, Chatham, stating as fully as necessary what his requirements are, and every endeavour will be made to supply or procure the information.

GENERAL THEORY AND PRACTICE.

ELEMENTARY LESSONS IN ELECTRICITY AND MAGNETISM.—By S. P. Thompson. Pub. Macmillan & Co. 1915. 5/6.

This book may well be looked upon as the standard "first-book" in electrical engineering. It is probably more widely used than any other book on the subject. The first edition was published nearly 40 years ago but the latest edition is as up to date as anyone could wish.

Synopsis.—Frictional Electricity. Magnetism. Current Electricity. Electrostatics. Electro magnetics. Measurement of Currents, etc. Electric Production of Heat. Electric Light. Inductance. Dynamos. Alternators and Transformers. Transmission and Distribution of Power. Electric Traction. Electro-chemistry. Telegraphy. Electric Waves. Wireless Telegraphy. Electron Theory of Electricity.

PRACTICAL ELECTRICITY.—By W. E. Ayrton and T. E. Mather. Reprinted, 1919. Published by Cassell & Co., Ltd. 10/6.

This book is described as being chiefly intended for students following a first-year lecture and laboratory course in electrical engineering. A good feature is the number of clear and often novel diagrams. The system of using mechanical analogies to explain electrical phenomena is freely used.

Synopsis.—The Electric Current and its Measurement. Magnetic Fields. Galvanometers, Electro dynamometers and Ammeters. Difference of Potential and Resistance. Galvanic Cells. Resistance: its laws and measurement. Electric Energy and Power. Quantity and Capacity. Potentiometer Measurements. Induced currents. Magnetisation of Iron.

A TEXT BOOK OF ELECTRICAL ENGINEERING.—By A. Thomälen. Translated by G. W. O. Howe. Published by Edw. Arnold. New Edition shortly.

This book bridges the gap between the elementary text books and the specialised works on various branches of electrical engineering. It deals almost exclusively with principles and does not enter into details of the practical construction of apparatus and machines. For the examination, either graphically or mathematically, of the behaviour of various electrical machines and apparatus it would be hard to find a better book. A new edition, completely re-written, is now in the press and will be published very shortly.

Synopsis of 1907 Edition.—Elementary Magnetism. Electro-magnetic Induction. Units. Armature Windings. Field Excitation and Commutation. Characteristics of C.C. Generators. C.C. Motors. A.C. Theory. Transformers. A.C. Generators. Synchronous Motors. Induction Motors. Commutator Motors. Converters.

ELECTRICAL ENGINEERING PRACTICE.—By J. W. Meares. E. & F. N. Spon. 1917. 25/-.

The first part of this book deals with elementary principles and the information given is accurate and precise. The second part, which treats with wiring and the domestic applications of electricity, is excellent and contains a good deal of valuable information. The third part, Electric Plant and Supply, is more variable in character, some subjects receiving scantier treatment than they deserve. On the whole it is a valuable work of reference which covers a wide field.

Synopsis.—Part I.—Explanation of Terms. Electrical Connections. Systems of Supply.

Part II.—Electric Lighting. Domestic Applications of Electricity. Cables and their Protection. Accessories of an Electric Installation. Control and Wiring of Branch Circuits. Systems of Installing Wiring. Cost of an Electric Installation.

Part III.—Electric Driving and Motors. Plant for Private Supply. Purchase of Electrical Energy; Public Supply. Water Power. Electric Traction. Electric Road Vehicles. Electricity in Mining. Transmission of Power. Specifications; Depreciation and Maintenance. Testing.

PRACTICAL ELECTRICITY.—By Terrell Croft. Hill Publishing Co. 1917. 10/6.

This book can be recommended as a text-book on the fundamental principles of electrical engineering. Ample use is made of analogies and the illustrations are numerous and excellent. Considerable space is devoted to explaining the relation between matter and electricity, and the electron theory is widely utilized for explanations.

Sections 1—20.—Principles of Electricity and Magnetism. Sections 21—28.—Electro-magnetic Induction, Inductance, etc. Sections 29—36.—D.C. Generators. Sections 37—40.—D.C. Motors. Sections 41—52.—A.C. Principles and Machines. Section 53.—Threewire Distribution and Systems.

CONTINUOUS CURRENT ENGINEERING.—By A. Hay. Constable & Co. 7/6.

This book rather belies its title. It deals with the component parts of continuous current lighting and power plant rather than the utilization thereof in one system. It is notable for clear form of expression and straightforward reasoning.

Contents.—Electrical Units. Electromagnets. Magnetism. Hysteresis. Measuring Instruments. Dynamo Construction. Dynamo Used as Motor. Construction and Management of Motors. Secondary Cells and Their Uses. The Electric Arc. Mercury Vapour Lamps. Incandescent Lamps. Photometry. Switches. Conductors. Insulation.

ELECTRIC LIGHT AND POWER.—By E. E. Brooks and W. H. N. James. Methuen. 1919. 6/6.

This is an excellent little book, which describes in simple language and without going too deeply into theory the principles upon which the provision of electric lights and electric power depend. Some commercial application of these principles are quoted, though mainly in further explanation thereof.

Synopsis.—Lines of Magnetic Force. The Magnetic Effect of an Electric Current. The Electric Circuit. Resistance. Electro-magnetic Induction. Induction Coils and Transformers, Self-induction. Current Generators. C.C. Motors. Lighting Circuits. Lamps. Measuring Instruments. Primary Cells and Accumulators.

GENERATORS AND MOTORS.

DYNAMO-ELECTRIC MACHINERY.—By S. P. Thompson. E. and F. N. Spon. Vol. I., Continuous Current Machinery. New Edition in preparation. Vol. II., Alternating Current Machinery. 1905. £1 15s.

These can well be described as the standard works on C.C. and A.C. Machinery, dealing with all the technicalities of construction and results of actual performance.

Synopsis.—Vol. II.—Principles of Alternating Currents. Periodic Functions. Alternators. On Induced E.M.F. and Wave Forms of Alternators. Magnetic Leakage and Armature Reactions. Winding Schemes for Alternators. Design of Alternators. Compounding of Alternators. Examples of Modern Alternators. Turbo-Alternators. Synchronous Motors. Motor Generators, Converters. Parallel Running of Alternators. Transformers. Design of Transformers. Induction Motors. Design of Induction Motors. Examples of Induction Motors. Single-Phase Induction Motors. Alternating Current Commutator Motors. Standard Voltages and Frequencies.

ELECTRIC MOTORS.—By H. M. Hobart. Pitman & Sons. 1911. 21/-.

This treatise deals with Continuous, Polyphase and Single-phase Motors in an exhaustive fashion, as the synopsis of contents will show.

Contents.—Part I. *Continuous Motors.*—General Discussion of Continuous Motors. Data for Motor Designing. Types of Armature Windings. Compound-wound Series and Shunt Motors. Hopkinson Method of Motor Testing. Commutator Design. Comparative Designs for 35-H.-P. Motor. Examples of Shunt Motor Designs. Examples of Designs of Compound Motors. Interpole Motors. Variable-speed Motors. Traction Motors. Part II.—*Alternating Motors.*—Desirability of using Polyphase Electricity. Methods of Starting Induction Motors. Comparisons between Induction and Continuous Motors. Squirrel-cage and Slip-ring Induction Motors. The Design of Three-phase Induction Motors. The Circle Diagram and its Practical Applications. Torque of Induction Motors. The Circle Coefficient. Heating of Induction Motors. Calculation of Loss in Squirrel-cage Rotors. Examples of Squirrel-cage Induction Motor Design. Examples of Three-phase,

Slip-ring Induction Motors of Small Outputs. Examples of Three-phase Induction Motor Designs, employing Wound Rotors, having Medium Outputs. Examples of Three-phase Induction Motor Designs, employing Wound Rotors, having Large Outputs. The Hunt Squirrel Cage. Variable-speed Polyphase Motor. The Design of Small Motors for Manufacture in Large Quantities. Cost and Weight Co-efficient of Induction Motors. Part III.—*Single-phase Motors.*—The Single-phase Induction Motor without a Commutator. The Single-phase Series Motor. The Repulsion Motor. Compensated Repulsion Motor. Other Single-phase Railway Motors. The Déri Repulsion Motor. Creedy's Design of an Atkinson Repulsion Motor. The Wagner Single-phase Commutator Motor. The Schüler Motor. Variable Pole Repulsion Induction Single-phase Motor. Shunt Single-phase Commutator Motor.

ALTERNATING CURRENTS.

PRACTICAL ALTERNATING CURRENTS AND ALTERNATING CURRENT TESTING.—By C. F. Smith. Sc. Pub. Co., Manchester. 8/-.

Despite the difficulty of dealing with A.C. working without using higher mathematics the author has nevertheless fulfilled his object satisfactorily and treated the subject from a practical rather than from a theoretical standpoint. Full use is made of graphical methods of explanation and vector diagrams and actual results of experiments are given in many cases in preference to generalisations.

Synopsis.—Alternating Electromotive Force and Current. Impedance. Power and Power Factor. Virtual Value of an Alternating Current. Effect of Capacity. The Transformer. Alternators. Synchronous Motors. The Polyphase Circuit. The Rotary Converter. The Polyphase Inductor Motor. Single-phase Motors. The Composition of Waves.

ALTERNATING CURRENTS IN THEORY AND PRACTICE.—By W. H. N. James. Camb. Univ. Press. 1916. 10/6.

This book is recommended because it combines an account of the laws governing the flow of Alternating Currents with a fair amount of matter on actual machines and appliances. The arrangement of the book is good and the reasoning clear.

Synopsis.—Preliminary Considerations. Inductance. The flow of Single Phase Alternating Currents in Circuits possessing Resistance, Inductance and Capacity. Power in Alternating Current Circuits. Multiphase Currents. Instruments for use on Alternating Current circuits. Alternators. Static Transformers. Induction Motors. Converting Plant. Switchgear and Protective Appliances. High Tension Transmission.

ELEMENTARY THEORY OF ALTERNATE CURRENT WORKING.—By G. L. Hall. *Electrician.* 1913. *Out of print at present.*

In the opinion of many this is quite one of the best books on the theory of alternating current. The author confines himself to theory, no mention being made of the design and construction of actual machines, but the treatment given is very simple and logical. It is essentially a common-sense book and the endeavour to "rob electrical phenomena of the mystery with which they are so often associated in the mind of the beginner" has been eminently successful.

Synopsis.—Alternating Currents. Inductance. Capacity. Resonance. Power Measurement. Polyphase Systems. Transformers. Generators. Synchronous Motors. Induction Motors. Commutator Motors.

METERS.

INDUSTRIAL ELECTRICAL MEASURING INSTRUMENTS.—By Kenelm Edgcumbe. Constable. 1918. 16/-.

As a reference book upon the recent developments in measuring instruments generally this is most comprehensive. All types of instruments are discussed and the reproduction of photographic views of instrument cases, which tell nothing, is sedulously avoided.

BATTERIES.

PRIMARY BATTERIES: THEIR THEORY, CONSTRUCTION AND USE.—By W. R. Cooper. Benn Bros., Ltd. 1917. 15/-. This may be regarded as the standard book on the subject of Primary Batteries and is a very complete work. The latest edition has a new chapter on the theory, properties and uses of selenium cells.

STORAGE BATTERY PRACTICE.—By R. Rankin. Pitman & Sons. 7/6.

A practical handbook on the manufacture and properties of electric accumulators, their installation and operation.

Synopsis.—Introductory. Manufacture. Installation and Setting to Work. Properties of Secondary Cells. Practical Working of Cells. Overhauls and Repairs. The Uses and Operations of Stationary Batteries. Batteries for Train Lighting, Vehicles and Portable Work.

WIRING.

THE THEORY AND PRACTICE OF ELECTRIC WIRING.—By W. S. Ibbetson. E. and F. N. Spon. 1914. 6/-.

An elementary book dealing with the principles of wiring for students and wiremen generally.

Synopsis.—General Principles. Resistance. Measurement of Resistance. Ohm's Law. Filament Lamps. Arc Lamps. Distribution of Power. Instruments. Fuses, Cut-outs and Switches. Systems of Wiring. Joints, Soldering. Insulators and Cables. Batteries, Bells and Motors. Testing for Faults in Cables. Miscellaneous Wiring.

THE PRACTICE OF ELECTRICAL WIRING.—By D. S. Munro. Alabaster, Gatehouse and Kempe. 1913. 3/-.

This edition is now out of print but a new edition is in preparation. The old edition is an excellent practical book on the subject of wiring buildings, etc. for electric light. No mention is made of motors. Suitable methods of overcoming the obstacles ordinarily met with are clearly explained.

Synopsis.—Introduction. Historical. Methods of Distribution. Wires and their Insulation. Joints and Trims. Connectors and Looping. Wiring Systems. Insulator Systems. Wood Casing. Socket Systems. Screwed Tubing. Metal-sheathed Systems. Concentric Systems. Outlet and Circuit Boxes. Blocks, Grounds and Fixings. Accessories and Switching. Distributing Boards. Tools and Appliances. Wiring Plans. Procedure in Erection. Tests. Faults. Temporary and Portable Wiring. Mine Wiring. Ship Wiring. Fire and Life Risks. Specifications.

ELECTRIC WIRING, SWITCHES, FITTINGS AND LAMPS.—By W. Perren Maycock. *Electrician.* New edition shortly. 9/-.

A useful practical book for electric light engineer and wiremen.

Synopsis of 5th Edition.—Connection of Supply Mains. Distribution. Distribution Boards. Transformers and Automatic Switches. Private Dynamo-Accumulator Installations. Automatic Accumulator Switches. Switches, Ceiling Roses, Lamp-holders, etc. Simple Filament Lamp Circuits. Adapters, Plug Connections and Connectors. Circuits for Two-way and Intermediate Switches. Circuits for Full or Dim Lighting. Special Switches and their Uses. Detail Specifications. Metal and Carbon Filament Lamps. Lamps and Lampholder Connections for Special Purposes. Nernst Lamps. Arc Lamps. Mercury Vapour Lamps. Moore Vacuum Tube Lighting. Time Switches. Automatic Electric Signs. Electric Heating. Small Battery Charging Circuits. Motors. Systems of Wiring. Bells. Indicators. Telephones. Fire Alarms. Clocks. Tests and Testing.

DISTRIBUTION.

ELECTRIC MAINS AND DISTRIBUTING SYSTEMS.—By J. R. Dick and F. Fernie. *Electrician.* 1919. 18/-.

This is a revised edition of a book which has come to be regarded as a standard work on the subject. The requirements of the actual live engineer have not been lost sight of.

Synopsis.—Part I. *The Design of Cable Systems and the Calculation of Conductors.*—Introductory. Principles of Network Design. The Calculation of Distributors. The Association of Distributors and Feeders. The Design of Feeders. Special Types and Arrangements of Feeders. The Heating of Cables. Network Analysis. Power Networks. Three-wire Networks. Alternating and Polyphase Networks. Abnormal Pressure Rises on H.T. Alternating. E.H.T. and H.T. Systems: Supply in Bulk. Part II.—*The Installation and Maintenance of Cables and Cable Systems.*—The Construction and Properties of Cables. The Testing of Cables. Electrolysis on Underground Systems. Electric Osmose on Underground Systems. Causes of Faults—Measures for Preventing. Cable Ducts and Troughs. Choice of Cables and Methods of Laying. Laying of Cables and Ducts. Records of Mains and Allocation of Costs. Earthing. Locating Earths and Earth Indicators. Cable and Jointing Accessories. Joints, Boxes, Disconnecting Boxes and Pillars. Costs of Cables and Installation of Cables.

OVERHEAD TRANSMISSION LINES AND DISTRIBUTING CIRCUITS.—By F. Kapper. Constable & Co. 1915. 16/-.

This book explains the fundamental principles and gives the data essential to the proper carrying out of all the operations in connection with overhead distribution of electric light and power.

Synopsis.—Conductor Materials. Sag and Tension of Line. Design of Supporting Structures. Line Insulators. Wiring, including Earthing and Crossings. Erection. Surveying. Local Overhead Distributing Systems. Schedule of Prices. Regulations dealing with Erection and Operation.

SWITCHGEAR.

ELECTRIC SWITCH AND CONTROLLING GEAR. By C. C. Garrard. *Electrician*. New edition shortly. 25/-.

This is a specialised work dealing with appliances and devices for the control and regulation of pressure and current and can be recommended as a text-book for those interested in central station supply and transmission and, in fact, to all who have dealings with electrical machines. Generally speaking the contents of the 1917 edition included Materials, Circuit-breakers, Overload and Reverse power Relays, Field Regulators, Motor Starters, Switchboards, Instrument Transformers and Protection of circuits against damage from pressure rises, both internal and external in origin.

POWER STATIONS.

LARGE ELECTRIC POWER STATIONS: THEIR DESIGN AND CONSTRUCTION.—By Dr. G. Klingenberg. Crosby Lockwood & Son. 1917. 25/-.

Up-to-date works on power stations are notoriously difficult to come by, for the, reason that the trend of design is continually changing. In half of this book, however the author treats the subject from a general point of view in an able and instructive manner; the other half of the book is devoted to descriptions of particular stations.

POWER HOUSE DESIGN.—By J. F. C. Snell. Longmans, Green & Co. 1911. 22/6.

This book deals with the complete design of electric power stations and consists principally of the collection and classification of the experience of the author and other eminent engineers.

Synopsis.—General Principles of Power House Design. Choice of Site, Type of Plant. Buildings. Steam raising Plant. Steam and Feed Pipe Systems. Steam-driven Prime Movers. Condensers, Cooling Towers, Air Pumps, etc. Gas and Oil Engines. Hydro-electric Stations. Switchgear. Practical notes on Generators, Motors, Boosters, Transformers, etc. Small Power Houses and Sub-stations.

TESTING.

HANDBOOK OF ELECTRICAL TESTING.—By H. R. Kempe. E. and F. N. Spon. 1908. 25/-.

This is a standard book on the subject of testing and its popularity can be judged from the fact that the present is the seventh edition. It will be noticed that machine testing is not included.

Synopsis.—Simple Testing. Resistance Coil. Galvanometers. Shunts. Measurement of Galvanometer Resistance. Measurement of the Internal Resistance of Batteries. The Wheatstone Bridge. Localization of Faults. Keys, Switches, Condensers, and Batteries. Measurement of Potential. Measurement of Current Strength. Measurement of Electrostatic Capacity. The Thomson Quadrant Electrometer. Measurement of High Resistances. Measurement of Resistances by Potentials. Localization of Faults by Fall of Potentials. Tests during the Laying of a Cable. Joint Testing. Specific Measurements. Correction for Temperature. Localization of Faults of High Resistance. Localization of a Disconnexion Fault in a Cable. A Method of Localizing Earth Faults in Cables. Galvanometer Resistance. Specification for Manufacture of Cable. System of Testing Cable during Manufacture. Appendix. Tables.

PRACTICAL TESTING OF DYNAMOS AND MOTORS.—By C. F. Smith. Sc. Pub. Coy. Manchester. 6/6.

This is an excellent practical book, with good diagrams and numerous curves taken from actual tests, though continuous-current dynamo machinery only is dealt with.

Synopsis.—General Purpose of Tests. Measurement of Armature and Field Resistances. Production of Electromotive Force in a Dynamo. The Magnetic Circuit. Armature Reactions. Shunt-wound Dynamo. Series Dynamo. Compound Dynamo. Effect of Current in the Motor Armature. Efficiency Tests of a Motor. Efficiency Tests of a Dynamo. Miscellaneous Tests. Motor Generators and Boosters.

HANDBOOKS.

STANDARD HANDBOOK FOR ELECTRICAL ENGINEERS.—By F. F Fowle. Hill Publishing Co. Dec. 1915. 30/-.

This book is the joint production of over 60 leading Engineers. There are 95 sections with the subject matter grouped so that you can find all the material on a given subject in one section. Every subject is fully and carefully indexed.

Contents.—Units, etc. Electric and Magnetic Circuits. Measurements and Measuring Apparatus. Properties of Materials. Magnets, Induction Coils, Condensers and Resistors. Transformers and Rectifiers. A.C. Generators and Motors. D.C. Generators and Motors. Convertors and Double Current Generators. Power Plants. Power Transmission. Distribution Systems. Interior Wiring. Illumination.

Application of Motors. Electric Railways. Electric Commercial Vehicles. Electric Ship Propulsion. Electro-chemistry. Batteries. Telephony, Telegraphy, and Radio-Telegraphy. Miscellaneous Applications. Mechanical Section. Standardization Rules (American). Engineering and Central Station Economics.

GLOVER'S VADE MECUM.—W. T. Glover & Co. 1918. 12/6.

A very useful little book. Giving full details of cables and their employment for overhead and underground distribution of electrical energy.

Synopsis.—Manufacture of Cables. Cable Laying and Cable Jointing. Colliery Cables. Overhead Lines. Maintenance and Testing. Useful data and formulæ. Regulations governing Installation and Supply of Electricity.

FOWLER'S ELECTRICAL ENGINEERS' POCKET BOOK.—Sc. Pub. Coy. Manchester. 3/-.

A highly useful compendium at a remarkably low price.

Synopsis.—Electrical Units. Magnets and Magnetic Data. Physical Properties of Metals. Conductors. Insulating Materials. Electric Lighting. Electric Welding. Comparison and Measurement of Resistances. Testing Sets. Electrical Measuring Instruments. Electricity Meters. Electro-Plating. Primary Batteries. Secondary Batteries. The Dynamo and Motor. Testing Dynamos and Motors. Power and Efficiency of Motors. Management of Dynamos. Alternate Electric Currents. Polyphase Alternating Currents. Alternate Current Machines. Transformers. Alternate Current Motors. Switchboards. Circuit Breakers and Lightning Arresters. Electrical Power Distribution. Rotary Converters. Electric Traction. Electrical Power Plant. Board of Trade and other Rules and Regulations, with Numerous Tables, etc.

ELECTRICAL TABLES AND MEMORANDA.—By S. P. Thompson. E. and F. N. Spon. 1919. 2/-.

A waistcoat-pocket book which is truly a *multum in parvo*. As a "pocket memory" it is most useful.

Contents.—Electrical Units. Primary Batteries. Accumulators. Circuits and Conductors. Losses in Cables. Insulating Materials. House Wiring. Underground Cables. Aerial Conductors. Measuring Instruments. Electro-metallurgy. Arc Lamps. Incandescent Lamps. Vapour Lamps. Illumination. Domestic Applications. Cost of Electrical Energy. Institution of Electrical Engineers' Wiring Rules. Care of Installations. Magnetic Units. Magnetic Properties of Iron and Steel. Energy Loss by Hysteresis. Law of Magnetic Circuit. Winding of Electromagnets. Permanent Magnets. Continuous-current Motors. Alternating Currents. Power in Alternating-current Circuits. Tables of Wire Gauges. Conversion Factors. Mathematical Tables. Index.

(Copies of these books are being placed in the R.E. Corps Library.—ED., *R.E.J.*)

REVIEWS.

THE DEFEAT OF AUSTRIA AS SEEN BY THE 7TH DIVISION. By THE REV. E. C. CROSSE, D.S.O., M.C. (H. F. W. Deane & Sons. The Year Book Press Ltd.). Price 7/6.

This is an extremely interesting account of the final operations of the 7th Division in Italy in the last days of October 1918, and includes descriptions of the crossing of the Piave at Papadopoli Island, the bridging of the river, and the final rout of the Austrians at the Tagliamento. As Major General T. H. Shoubridge says in the Foreword, the book will rank as history as far as the incidents it describes, and yet it is not dry history, and the pill, if it is a pill, is well gilded. The chapter on the Building of the Bridge will be read with interest by Royal Engineers, and if ample credit is given to the excellence of the equipment and to the skill of the Italian *pontieri* who placed four pontoons in the worst part of the stream, the good work done by the 95th and 54th Field Companies R.E., under Majors Clifford and Boulnois, with the assistance of engineers from the 23rd Division and the XIV Corps, is fully recognised. In places the author is at fault in his compass-points, as for instance on pages 36 and 37 in describing the capture of the Island, but the excellence of his maps leaves no opening for misunderstanding the details of the fighting. The book is abundantly illustrated.

F.E.G.S.

STIRRING DEEDS IN THE GREAT WAR. By CHARLES E. PEARCE. (Stanley Paul & Co. 6/-.)

An attractive collection of war yarns which would be appreciated by the younger generation.

F.E.G.S.

NOTICES OF MAGAZINES.

JOURNAL OF THE UNITED SERVICE INSTITUTION OF INDIA.

In the number of this *Journal* for October 1919 there appears an article by Major C. F. Stoehr R.E. on the subject of the Future Organization and Training of the Sappers and Miners. Major Stoehr points out that although the Sappers and Miners during the Great War have shewn by their services in France, East Africa, Mesopotamia, Egypt, and Palestine that their peace-time organization and training were fundamentally sound, yet some weak points have come to notice, the principal of which appear to be :—

(1) The absence of an efficient reserve, a defect which they share with the whole Indian Army ;

(2) Scarcity of Officers who know anything of a Sapper and Miner Company, with which may be coupled lack of sufficient technical engineering knowledge on the part of S. and M. officers and also the probability that the C.R.E. of a Division will either have little or no knowledge of the units under him, or will not be in a position to deal as efficiently as he might with the engineering problems which he will have to solve ;

(3) Failure of the staff to get the best use out of S. and M. Companies, these two last defects showing lack of touch between S. and M. and other R.E. officers and between S. and M. and the staff ; and

(4) Necessity of reconsidering the data on which the transport and equipment of a company have been based.

As a remedy for (2) he proposes that every officer should spend his first year in India in Military Works and his second year in Sappers and Miners. He would then learn the routine of Military Works and study the language in a post where it is not essential, while his second year would enable him to drop into his place at once if subsequently from other work he should be attached to a S. and M. Company for active service.

If after his second year he decided to make his career in Sappers and Miners, he should be allowed to remain with them for another five years and should then be sent to Military Works, preferably on the frontier, for two years or until he should be appointed to command a Company. He should also spend another two years on Military Works before obtaining the appointment of Superintendent of Park or of Instruction.

As regards the third defect no Division in India in peace-time should be without three Sapper and Miner Companies and a headquarters of Divisional Engineers. But the detachment of such a large number of companies would be difficult to reconcile with the continued existence of the three Corps of Indian Sappers, whose retention is desirable from the point of view of sentiment and *esprit de corps*.

But would not the three Corps organization still be necessary for the training of officers and especially of the men? As Major Stoehr says, very nearly all sappers are taken from the plough. The training of artificers is a matter of years, and it is doubtful if it could be done efficiently at a Divisional Engineer headquarters. Major Stoehr suggests that it can. Otherwise it should not be difficult to graft a Divisional Engineer system on to the existing organization of C.R.E's and A.C.R.E's.

On the subject of transport and equipment, it is a question whether in view of the greater weight of equipment of all sorts which now accompanies an Army, and the enormous development of motor transport, operations on the frontier will not in future have a wheeled road for at least their main line of communication, and whether a large proportion of the equipment of S. and M. Companies should not in future be carried on carts.

F.E.G.S.

THE MILITÄR-WOCHENBLATT.

November, 1919.

The efforts to keep up the old army spirit and to maintain the old status of the officer class are very evident in the November numbers. Courts of honour, it is proposed, should be kept up; the old uniform will not disappear as it may be worn by retired officers. The formation of Regimental Unions goes on gaily. The latest excuse for the loss of the war is that Germany did not raise and train in peace as many men as she could have done. This was not the fault of the General Staff but of the Reichstag and particularly of the Left.

No. 54.

The Miracle of the Marne.—This is mainly a review of General Baumgarten-Crusius' work on the battle of the Marne (reviewed in *The Times Literary Supplement* of 13th November, 1919), in which so many secrets were revealed, particularly the mysterious part played by Lt.-Colonel Hentsch, the emissary from O.H.L., in ordering the retreat. The article quotes from Helfferich's account of his impressions at O.H.L. on the 4th September. The Kaiser said to him "This is the 35th day after mobilization; Rheims is in our possession, the French Government has gone to Bordeaux and our cavalry is 30 miles from Paris." On the other hand von Moltke was anxious and depressed. He said "We have been successful but have not yet won, we have hardly a horse that can go out of a walk. Don't let us deceive ourselves. Victory means annihilation of the enemy's power of resistance. When millions face millions, a victor has lots of prisoners. Where are ours? We got some 20,000 in the Lorraine battles, 10,000 here and another 20,000 there perhaps. The relatively small number of captured guns also show me that the French have retired according to plan and in good order. The hardest task is still in front of us." The Germans now endeavour to

make out that the retreat from the Marne was the mistake of a junior officer or due to von Moltke's weakness. Those who believe in Providence will be more inclined to say that a lying spirit was put into the mouths of the Kaiser's advisers, and that the German defeat was indeed a miracle.

Where is Tradition?—A wail that German officers now attack and throw mud at each other in the public press, and appeals to them to make up their differences and show the united front of pre-war days.

The One-Year-Volunteer Certificate as a Factor in Education.—A regret the incentive to work at school, and obtain the certificate that entitled the holder to present himself for service as a one-year-volunteer, has been removed by the abolition of compulsory service.

End of Bestowal of Decorations for the Campaign 1914-18.—An official notice states that no recommendation will be accepted after the 30th November, 1919.

No. 55.

Causes of the German Capitulation of 11th November, 1918.—Reviews a book by a Colonel Schwertfeger which endeavours to disprove the statements in the French General Staff pamphlet describing the desperate state of the German Western Armies in November, 1918. Colonel S's point seems to be that we should only regard the German army as it was on the 5th October, 1918, when an armistice was asked for, and that the disasters which overtook it between that date and 11th November, and the others that were awaiting it should not be taken into account!

The Military-Political Events in Russia (Middle of September to Middle of October).—A useful summary, continued in the next number.

Cyclist Units for the National Army advocates that as much as possible of the small army allowed to Germany by the Peace Treaty should be put on wheels.

Roll of Honour.—Dragoon Regiment No. 13: 31 officers and 289 other ranks killed. Guard Pioneer Battalion: 59 officers, 208 N.C.O.'s and 1147 men killed. The battalion was disbanded on 14th April, 1919.

No. 56.

The Military-Political World Situation.—The ratification of the peace terms is not expected before January or February. It is insinuated that it suits England and France best to keep the indeterminate stage between peace and war open as long as possible.

The New Polish Army.—The increasing importance of the new Polish army is pointed out; and it is asserted that it consists of 550,000 men with up-to-date material. Prussia only kept 15,000 men in Posen province, in the portion of it occupied by Poland there are 60,000 to 70,000.

Gazette.—This contains the new heading "Appointments in the New Army (200,000 men strong)."

Roll of Honour.—The Staff of the Cadet School at Köslin: 10 officers killed.

No. 57.

Promotion and Brevet Promotion of Officers.—This combats an article in the *Kreuz-Zeitung* that argued that officers who accepted promotion

from the New Government thereby lost their claim to be considered " Royal Prussian officers."

Regimental Unions of the Old Army.—The formation of these useful nuclei goes on merrily. There are now 72. The names and addresses of the officer " who represents the interests of the unit " are given.

Field Marshal Graf Haeseler in the War.—Some anecdotes. It is related that at the passage of the Meuse at Sivry, 1st September, 1914, he sat on a chair at the bridge under artillery fire to steady the troops, who were not crossing as they should.

Roll of Honour.—Jäger Battalion No. 4. This battalion formed one field, one Ersatz and two Reserve battalions and 3 cyclists companies: 80 officers and nearly 2700 other ranks killed.

No. 58.

Voluntary Courts of Honour for Officers.—The National Assembly has abolished the old courts of honour (which settled cases in which an officer's honour was engaged, ordered duels, etc.) and suggests that they should be kept up voluntarily to maintain the status of the officer caste.

The Economical Position of Officers.—The old allowances given to assist officers on retirement to start in civil life have apparently been abolished.

Field Marshal Graf Haeseler.—Further anecdotes. On one occasion he said " What more can a man want than drill on the barrack square: he has fresh air and exercise."

Diary of the War.—This is continued to the 11th November " when in consequence of the signing of the armistice hostilities cease." The entries during November only speak of a withdrawal according to plan: the enemy either ' is repulsed ' or ' follows.'

No. 59.

Article 104 of the Constitution of the Reich.—A Protest against the proposed new article of the Constitution that Military law shall not be applicable except in time of war and on board ships of war.

General Field Marshal Count von Haeseler on the World War.—An extract from Baron Eckardstein's memoirs is quoted which gives an account of his visit to Haeseler at Stenay on September, 1914. The old gentleman was in an attic surrounded with maps. He protested against the silly attitude of the German Press which was lying to the people about successes and assuring them that the French power of resistance was broken.

Contributions to the history of the War.—Extracts from the French *Journal Officiel* and *L'Echo de Paris* with regard to the secret sittings of the Chamber. In June, 1916, General Roques, the Minister of War, gave the following figures of the strength of the French armies

August, 1914	1,900,000
1st January, 1915	2,309,000
1st July, 1915	2,665,000
1st January, 1916	2,728,000
1st May, 1916	2,753,000

Of the last total 2,632,000 were with the Armies in France. There were 121,000 with the Army of the Orient, and 308,000 in Algeria and Morocco.

No. 60.

Czernin's Recollections.—A review of Count Czernin's book in which are extracted all the phrases which might be interpreted to show that Austro-Hungary was not true to Germany. "There is not a hint that we continuously protected Hungary from Russian invasion by *German battalions*, which supported the always wavering (often deserting) Austrians."

The Supreme Command and its Most Important Decisions 1914–1916.—A Review of General von Falkenhayn's work in form of a summary. It does not bring out that Falkenhayn describes the successes in Russia at great length and slurs over Verdun and the Somme in a few pages, which bristle with the most transparent inaccuracies.

Roll of Honour.—Dragoon Regiment No. 1: 19 officers and about 100 other ranks killed. Field Artillery Regt. No. 66: 50 officers killed.

No. 61.

The Supreme Command and its Most Important Decisions 1914—1916.—Review continued. The review does not consider that Falkenhayn who was an ardent advocate of the Balkan campaign should be blamed for its "sad results."

The Guilt for the Loss of the War.—By Major General Von Kurnatowski, who combats the speech of a Free Conservative Member of the Reichstag in which he stated that the military leaders were partly responsible for the loss of the war. He insists that it was the shortsightedness of the Social Democrat members who refused in peace time the additional troops and war material for which the General Staff asked.

No. 62.

Distribution and Garrisons of the Reichswehr Troops.—This gives in tabular form the order of battle so far as it is formed, of the Berlin, Cassel, Kolberg and Munich Reichwehr-Gruppen Kommandos, a long word which camouflages Army Corps. Wehrkreis Kommando similarly conceals a division.

The new Army is organized in composite brigades; each brigade consists of

3 Infantry Regiments (see below)
1 Cyclist Co.
2 Cavalry Regiments
1 Light Artillery Regiment
1 Pioneer Battalion
1 Signal Section
1 Motor Transport Section
1 Medical Company

An infantry regiment consists of three or four battalions, a trench mortar company, a signal company, one or two machine gun companies, and an infantry gun battery.

A cavalry regiment has three squadrons and a machine gun squadron.

A light artillery regiment has three brigades and a trench mortar battery.

A pioneer battalion has two companies, a searchlight section and bridging train.

A signal section contains telephone, pigeon and listening subsections.

Uniform.—The old uniform will not disappear as officers on retirement are being given the right to wear it.

No. 63.

Reinforcement of the Army before the War.—General-Colonel von Heeringen a former War Minister has been writing to the *Kreuz Zeitung* to show that Germany lost the war because she did not make sufficient preparations and increase her army from 1909 onwards as it was in her power to do.

The obstacles were that the State Secretary of the Imperial Treasury Herr Wermoth opposed non-productive expenditure and that when he was got rid of in 1912, von Tirpitz competed for any money available and von Moltke didn't press enough. The War Office never opposed increase, it was the civilian treasury officials who lost the war because they would not agree to three more army corps.

Inquiry Commission of the Reichstag.—The instructions sent to and the doings of Count Bernstorff, the German Ambassador at Washington, it is suggested, might be made a subject of enquiry. He was completely deceived by President Wilson. It is hinted that he saw rather with the eyes of his American wife than with his own. She must therefore be placed high among the causes of the German defeat.

Field Marshal Count Haeseler as the Trainer of the German Army.—An absurd article. The old man has little claim to fame except a slight physical resemblance to von Moltke the elder and a military manner of a now obsolete type, which combined offensive curiosity with the manners of a drill serjeant.

O.H.L. and its most important decisions 1914-16 continued.

Roll of Honour.—Pioneer Battalion No. 3: 62 officers and over 1,000 other ranks killed. Two officers died of sickness.

No 64.

Dr. Theodor Toeche-Mittler.—Obituary notice of the head of the firm which publishes the *M.W.B.* He died on 24 November, 1919, aged 83.

Further Awards of the Long Service and Good Conduct Cross.—This is not one of the decorations to be abolished.

The Economical Position of Officers.—Notice that employment in the 200,000 strong New Army does not give right without question to allowances, or a claim to employment in the 100,000 strong Reichswehr, when peace is ratified.

The Next Three Wars.—Review of a book which prophesies that England having attacked and defeated Germany will in turn attack Japan, France and U.S.A.! The reviewer finds it cheering and a pleasant change from prevailing pessimism; he will hardly live long enough to see the fulfilment of his wishes.

No. 65.

The World Military-Political Situation.—This gives the proposed new peace organization of the French Army, viz. 350,000 men. Of this

total 200,000 are one-year service men; 30,000 N.C.O's; 20,000 Colonial troops in France; 50,000 volunteers and re-engaged men; 50,000 foreigners and natives of North Africa.

The writer warns against hopes of a possible disagreement between France and England, "robbers often fight over the spoil, but it hasn't come to this yet." He further warns against expectations from the delay of the U.S.A. in ratifying the Peace treaty. "Americans are business men and that only. . . . and they are creating a stronger army than they have ever had: 350,000 men perhaps 500,000."

Military-Political Events in Russia.—The blame for the continuance of Bolshevism is thrown on England, who is engaged on only English not anti-Bolshevic policy.

Roll of Honour.—Foot Artillery Regiment No. 8: 27 officers, 63 N.C.O's and 412 other ranks killed. Infantry Regiment No. 459 formed in January 1917): 38 officers and 1180 other ranks killed.

J. E. EDMONDS.

REVUE MILITAIRE GÉNÉRALE.

August—September, 1919.

It is announced, in an editorial note, that General de Lacroix has resigned the post of Editor-in-Chief. In view of this fact the Management of the *Revue Militaire Générale* has decided to abandon its former policy and to make a start on fresh lines by making the columns of the publication a *tribune libre*.

Communications dealing with matters relating to the Great War are invited. The importance of obtaining a correct record of events, whilst details are fresh in the minds of the participants in episodes of historical interest, is recognised; hence the change in policy announced. The hope is expressed that contributions to the pages of the *Revue* will be of a nature to assist the General Staff in revising the regulations, and that they will prove, at the same time, of value from the standpoint of military history.

THE GERMAN ARMY BEFORE AND DURING THE GREAT WAR (1914–1918).

M. Camena d'Almeida, the author of the original article, has drawn largely for his material on the diaries of German officers and non-commissioned officers. The part of the article appearing in the number of the *Revue* under notice is devoted to the mobilization of the German Army.

Preparatory measures.—M. d'Almeida deals under this head with the steps taken in Germany to secure a secret mobilization of her army so that her preparations might be complete even before she proclaimed the intermediate state of existence between Peace and War, labelled "*der Zustand der drohenden Kriegsgefahr*" (the state of threatened War danger).

Some weeks before the proclamation was issued declaring a "state

of threatened War danger," reservists had received summonses calling them up for training for a period of 56 days, commencing on the 1st August. These notices were not dated, but evidence exists which indicates that they must have been sent out, at least, as early as the first days of July.

Although the "state of threatened War danger" was not proclaimed in Germany until the 31st July, entries in the diaries of German officers and non-commissioned officers prove conclusively that mobilization was in full progress, at least, as early as the 28th July. The German people appear to have had an inkling at this time that the authorities of the Wilhelmstrasse had irrevocably decided in favour of War; this conclusion is to be drawn from the fact that, on the 27th July, the Socialist party placarded Berlin with flaming posters denouncing warlike measures and calling a meeting for the following day to raise a protest against the Austrian ultimatum to Serbia. The police, naturally, took steps to prevent the masses obtaining access to the central quarters of Berlin; but huge crowds managed to assemble on the 28th July in the *Unter den Linden* and marched through this thoroughfare shouting: "Down with War! Down with Austria! Long live Peace! Long live the Republic!"

It was on the 27th July also that the ex-Kaiser, on his return from the Norwegian Fjords, arrived in Potsdam. The German public appears in no way to have been taken by surprise when, at noon on the 31st July, the proclamation announcing the "state of threatened War danger" was read at the *Zeughaus*, Berlin, by an officer of the 1st Regiment of Grenadier Guards.

"*The State of threatened War danger.*"—The general mobilization of the German Army was begun under the mask of the situation created by proclaiming a "state of threatened war danger." The evidence available shows that regiments on the frontier received their full complements of reservists by the 31st July; military guards were placed on certain important railways on the date last mentioned; battalions of the Landsturm began to be formed on the evening of the 31st July and eventually took over the guarding of the railways on the frontier from the regular troops on the 2nd August.

In order to excite indignation in the people, false reports were duly spread in the German Press. Two telegrams were published in Berlin with this object in view on the morning of the 31st July: in one of them it was stated that the Russians had crossed into E. Prussia; and in the other, it was announced that Russian patrols had advanced as far as Jarotschin, in the province of Posen, and had blown up the railway there. Similar reports were published in relation to the western frontier of Germany. The *Lokal Anzeiger* went so far as to make a premature announcement to the effect that a general mobilization had been ordered; this was probably done in accordance with a premeditated plan and with the design of testing the temper of the people. The die having been cast, the Brandenburg flag was hoisted, at noon on the 1st August, at the Royal Palace, and officers of the General Staff began at once to rush through the streets of Berlin in motor-cars informing the people that the orders for mobilization had been issued.—(*To be continued.*)

THE VERSAILLES TREATY OF PEACE AND MILITARY SERVICE.

General Thevenet is the author of the original article. He points out that the Treaty of Peace signed at Versailles on the 28th June, 1919 imposes on Germany conditions of a political, economic, and military nature which are dictated by a desire to put an end for ever to German Imperialism and to render possible the inauguration of a durable peace, the pressing necessity for which is felt throughout the entire world.

Among the military clauses of the Treaty is one which forbids Germany from and after the 31st March 1920 to maintain an army of more than 100,000 men; these men are to be enlisted voluntarily for long service. At the same time, her armaments and the manufacture of war material are strictly limited; conscription is abolished; her military frontier is fixed at a distance of 50 kilometres E. of the Rhine, with a prohibition against the construction and maintenance of fortifications and the assembly, maintenance or movement of armed forces within the neutral zone so created. Finally, in order to ensure the execution by Germany of the terms of the Treaty, troops belonging to the Allied and Associated Powers are to remain in occupation of the E. bank of the Rhine for a period of 15 years.

Although the responsibility for enforcing the terms of the Treaty and respect for the provisions of international law rests with the League of Nations, nevertheless, in view of the peculiar dangers to which France would be exposed in the event of non-observance by Germany of the conditions imposed upon her, Great Britain and the United States of America have entered into special treaties with France undertaking to render her immediate assistance in the event of an unprovoked aggression on the part of Germany.

The Treaty has given rise to considerable discussion and it is evident that many Frenchmen feel that no adequate security against a repetition of the experiences which France has had to undergo in the Great War is afforded under its terms. General Thevenet points out that although Germany has been beaten, and is for the time being precluded from doing any further mischief, yet it would be under-estimating her vitality, energy, and power of organization to assume that she will willingly remain a docile tributary of her conquerors for long. Attention is called to statements recently made by the Prussian Home Secretary and to views expressed in the *Zeit*, which clearly indicate that Germany intends at the earliest moment to tear the Treaty of June 1919 to shreds.

General Thevenet calls attention to the fact that the creation of the neutral zone on the E. bank of the Rhine should, in the case of an aggression on the part of Germany, afford France *time* and *space*: *time* in which to prepare defences against the passage of the river, thus securing her against surprise and permitting the employment of adequate forces to oppose a German advance; *space*, should the river be crossed, to enable her to engage the enemy in his own territory and thus to preserve France from the horrors of an invasion.

It is urged that France should at all times permanently maintain on the frontier a strong force capable of meeting all eventualities. The time for *levées en masse* are, it is pointed out, past. Improvised armies, insufficiently provided with engines of war, etc., merely invite disaster. General Thevenet estimates that, by taking proper steps, sufficient men

can be trained in France to provide a national army of from 5 to 6 million men, who could be easily mobilised and held in immediate readiness to ward off any attack. He considers compulsory military service to be indispensable and suggests that, if it is applied methodically, it can be made to play an important rôle in the civic instruction of the rising generation. In December 1918, Mr. Daniels, Secretary to the Navy, made a somewhat similar statement regarding the rôle of the American Navy; the text of this statement is quoted in the original article.

General Thevenet in conclusion states that, only by the signatories to the Treaty of Versailles working harmoniously together, will it be possible to render its provisions effective and durable. He recognises that it is necessary for France to diminish her military expenditure; but, in his opinion, compulsory military service must be maintained by her, as being one of the surest guarantees for the peace of the world.

Man the Instrument of War.

Lieut. Col. Lucas, the author of the original article, points out in an introductory section to his article that although much has been already published relating to the splendid work of the *poilus* during the Great War, much more has still to be written. No one, who has not lived with the French Army can, he says, possibly understand the immensity of the sacrifice the *poilu* has made for his native land. He wishes his paper to be regarded merely as an introduction to the study of the infantry soldier as an instrument of war.

Know thy man should, he states, be borne in mind as a first axiom by every chief, senior or junior, who may be called upon to take command of a unit, or sub-unit, of infantry. Before a man can properly handle a tool, he must know all about it; so is it the case with that most highly developed and the most delicate of instruments in the world, the infantryman, his peculiarities must be learnt before he can be successfully handled.

Col. Lucas points out that the basis of all study of the infantry combat *is experiment*; both that of peace manœuvres as well as that resulting from observations made in the course of a war. He examines the views on this subject expressed by such well known writers as General Moraud and Colonel Ardant Du Picq; many extracts from whose writings appear in the original article.

The question of the training of the infantry soldier is dealt with at some length in the original article. Col. Lucas treats the subject under five heads:—

1. The main characteristics of modern combats.
2. The *morale* of the combatant.
3. The good and bad points in the French soldier.
4. The influence of organization and military training.
5. Conclusion.

The article does not lend itself readily to condensation. Col. Lucas shows that the constant pre-occupation of all great commanders has been the study of the characteristics and temperament of the troops that they have been called upon to lead in war, and he urges that in view

of the importance of the subject steps should be taken to provide special instruction on the psychology of the soldier in all courses for officers and non-commissioned officers, so as to enable them to acquire a correct appreciation of the qualities of the man and his mentality, since this is the foundation upon which all military training must rest.

JOTTINGS.

The Peace Treaty is briefly discussed. It is pointed out that the statesmen charged with the duty of liquidating the situation created by the Great War had two solutions of the problem before them: one, that of rendering Germany harmless by carving her up; and the other, that of maintaining Germany in a sufficiently strong position such as to render her capable by the labour of her people to pay off to her conquerors the enormous liabilities created by her conduct. It is the second of these solutions that has been accepted. Germany remains a united nation of 70 million souls and she has not renounced her intention of annexing German Austria.

Some perturbation has been caused in France owing to the attitude of the British Government in relation to Syria; and at the same time, anxiety has been caused owing to the refusal of the American Senate to ratify the Peace Treaty.

Reference is made to the energetic action taken by the Entente in securing the abandonment of Article 61 of the new German Constitution, whereby it was intended to annex Austria out and out to the German Empire.

Russia, it is pointed out, remains the great unknown quantity in the reconstructed world. The situation there affords a fine field of action to French politicians and diplomats, but one containing many pit-falls.

BIBLIOGRAPHY.

Short notices are published of Fernand Engerand's *Le Secret de la Frontière* (1815—1871—1914), *Charleroi* and of Jean Fleurier's *Mon Sac*.

A summary is given of the titles of articles of interest appearing in foreign military periodicals, and the appropriate references.

W. A. J. O'MEARA.

REVUE MILITAIRE SUISSE.

No. 11.—*November*, 1919.

ARTILLERY SIGHTS.

The original article is based on an interview with Colonel C. Dapples of Lausanne, the inventor of the metric system of graduating artillery sights, the so-called *millième de l'artilleur*. This system of graduating artillery sights was first introduced in Switzerland in 1864; it consists in taking the length of the line of sight, whatever it may be, as a *unit*, and in graduating the tangent-sight so that its divisions represent $\frac{1}{1000}$ths

of this *unit, i.e.*, divisions, which up to a range of 3,000 paces, represent the *natural tangent* of the angles of elevation. Prior to the War the *millième* had been accepted in practically every country, except Great Britain, as the basis for graduating artillery sights. The Americans adopted the *millième* in 1908, but it wanted the Great War to move the British to surrender their traditional method of marking artillery sights in degrees and in parts of an inch. To-day, the same method is employed throughout the world for graduating artillery sights, much to the satisfaction of the inventor of the artilleryman's *millième*.

Notes and News.

Switzerland.—In France, Germany and in other parts of the world the reorganization of the national armies is now far advanced. It seems to be anticipated that some way round will be found in Germany for evading the spirit of the Peace Treaty, although its terms may be observed to the letter. The view prevails that conscription will be retained in the French Army; opinions are divided as to what shall be the period of colour service. Proposals as to the length of colour service vary from 8 to 12 months; it is probable that the latter period will eventually be decided upon. Owing to the elections the question of army reorganization has been abeyance in Italy; it is expected that the duration of colour service will be shortened considerably. Austria has, from the military point of view, ceased to exist; only in the Czech and Slav States are there armed forces. In Switzerland, the General Staff is still engaged on the question of army re-organization; it is thought that no changes of a fundamental character will be made. The vote for the Swiss Army, which was 45 million francs before the War, has been fixed at 50 million francs for 1920; in view of the difference in the buying power of the franc, the larger vote represents by comparison a reduction of 45% on pre-war military expenditure.

The question of Switzerland joining the League of Nations was proposed at a reunion of the students of the *Helvétia*. After discussion the vote was taken and a resolution carried in favour of Switzerland becoming a member of the League.

The present Swiss War Minister will shortly be retiring from office; his successor is not yet named. Colonel Bridel is to replace Colonel Kunz as Director General of Artillery.

It would appear that Germany is intriguing to establish herself in the Vorarlberg, an intensive German propaganda has been launched in this region. Further, the Deutsche Bank is negotiating the purchase of the water-power of the Upper Rhine on behalf of the A.E.G.

Portugal.—A special correspondent states that the issue of a White Book dealing with matters connected with the War is daily expected. He states that Portugal maintained an Army 50,000 strong in France, and at the same time sent 34,600 European troops to the two Africas; 19,500 native soldiers and auxiliaries were also maintained in the latter regions. The Portuguese casualties in France amounted to 14,623 officers and men, equivalent to about 27% of the Portuguese Army in that country; whilst the casualties in Africa are estimated at 21,000 officers and men, equivalent to 40% of the Portuguese force employed

in the Southern Continent. The Portuguese shipping sunk by the Germans amounted to 96,379 tons. Portugal expects to be rewarded for the part she played in the War by a rectification of the N. frontier of Mozambique, the restitution of Kionga and an indemnity to cover her War expenditure.

It is suggested that a small hamlet, with examples of Portuguese architecture, should be specially laid out as a Portuguese War Memorial in Flanders and that a site should likewise be dedicated to Portugal in France, in the region where Portuguese soldiers fought and died in the War for European Liberty and Civilization.

INFORMATION.

A strong Committee has been formed in connection with the continuance of the *Revue* during 1920. There seems to be a good prospect of sufficient support being obtained to justify the publication of this paper during next year.

BIBLIOGRAPHY.

Among the works noticed are: *Lille* by General Percin (Pub. by Bernard Grasset, Paris, at 3 fcs. 50 c.); *Der Ausbruch des grossen Krieges* by Cuno Hofer (Pub. by Schulthess et Cie, Zurich); and *Die Militärischen Ereignisse im Völkerkrieg* 1914—1918—this volume, which is printed at Munich, contains 230 war maps in colours shewing the 'fronts' held by the contending forces at various periods of the war. (Pub. at 70 marks.)

W. A. J. O'MEARA.

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This Journal, which was formerly known as the "Proceedings" of the R.A. Institution, contains articles and information on Artillery matters, some highly technical and some general. Articles on general Military topics also appear.

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