THE ROYAL ENGINEERS JOURNAL.—SEPTEMBER, 1919. Pages 97—160.

THE ROYAL ENGINEERS JOURNAL.

Vol. XXX. No. 3. SEPTEMBER, 1919.

CONTENTS.

OFFICERS OF THE SPECIAL RESERVE, TERRITORIAL FORCE, AND THE TEMPORARY LIST, ROYAL ENGINEERS AND MEMBERSHIP OF THE CORPS ASSOCIATIONS AND CLUBS.

PROCEEDINGS of Meeting of the R.E. Corps Committee held in Room 230, War Office, July 21st, 1919 (in accordance with the resolution agreed to at the Annual Corps Meeting on 14th June, 1919.)

The following were present:—Major-Generals Sir P. G. Twining, (D.F.W.), *S. H. Powell, (C.E., Forces in Great Britain), *L. Jones, (C.E., Eastern Command); Brig.-Generals T. A. H. Bigge, (A.A.G., R.E.), *A. L. Schreiber, (C.S.M.E.), *G. S. Cartwright, (C.E., Aldershot), A. W. Roper, (I.R.E.), *G. Walker, (C.E., London); Major L. Chenevix-Trench, (Hon. Sec., R.E. Corp Committee).

* Specially attended with power to vote in accordance with resolution dated 3rd July, 1919.

AGENDA.—To discuss Major.-General Sir P. G. Twining's proposal:—

That in the opinion of this Committee it is not only desirable but is necessary that all possible steps be taken towards preserving the feeling of friendship and *cameraderie* which existed during the war between the Regular Corps of R.E. and the Special Reserve, Territorial, and Temporary Officers and Men, and that as a means to this end the R.E. Institute, and as far as possible other Corps Institutions, should be thrown open to these officers, and that steps be taken to bring this as far as possible to the notice of all such officers.

ACTA.—The opinions of the Presidents of the several R.E. Corps Institutions were read, and following conclusions reached:—

R.E. Widows' Society, R.E. Band Fund.—The deed of settlement in the one case and Army Orders in the other preclude the possibility of an extended Membership.

R.E. Institute.—Already accepts *all* R.E. Officers (including S.R., T.F., and T.C.).

R.E. Charitable Fund.—Already accepts *all* R.E. including S.R., T.F., and New Armies.

R.E. Games Fund.—Terms of admission to be considered by Games Committee.

R.E. Entertainment Fund, R.E. Dinner Club, R.E. Luncheon Club.—Officers of the T.F. and S.R. and Temporary Officers will be welcomed at the Annual Dinner and the Annual Evening Entertainment, and the Luncheon Club tent will be open to them.

R.E. Old Comrades' Association.—Already open to *all* Members of Corps of R.E. including S.R., T.F., and New Armies.

CONTENTS.

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

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 annually by the Institute Council in the manner they consider best for the encouragement of contributions on professional subjects, by R.E. Officers, to the Corps publications. For the present the prize shall be confined to officers on the active list below the rank of 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 coat-of-arms in gilt on the cover and 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.

WATER SUPPLY DURING THE OPERATIONS AGAINST BEERSHEBA AND GAZA, NOVEMBER, 1917.

THE army which crossed the Sinai Desert into Palestine and then deploying on a broad front, enveloped the Turkish position extending from Beersheba to Gaza, demanded much of its engineers. During its deliberate advance it was followed by a broad gauge railway and a piped supply of filtered water from Kantara, on the Suez Canal, into the field of battle near Beersheba, a distance of 147 miles.

It would be an exaggeration to say that there is no water in the Sinai Peninsula, which separates Egypt from Palestine, but the supplies are so scanty and bad that the desert has always been a very formidable obstacle to the passage of troops. The only practicable route across this desert runs along its northern edge where scanty supplies of water are found in small wells on the caravan route or by digging new wells in the sand dunes, but, nearly all water in these wells is brackish and unpalatable and as a supply it is quite inadequate for a large force followed by an army of labourers constructing a railway. It was therefore necessary to provide the army with water from some source outside Sinai.

The water supply system, as originally planned, was only intended to supply 500,000 gallons a day for a force of one Mounted and two Infantry Divisions detailed to recapture the Egyptian town of El Arish, which was in the hands of the Turks, but, as it was extended beyond there and proved to be an important factor in subsequent operations it must be briefly described.

On the west bank of the Suez Canal, at its northern end, runs the Port Said branch of the Sweet Water Canal which carries the water of the Nile to that town. In the autumn of 1916, plant to filter 600,000 gallons of water per day was installed on the Sweet Water Canal at Kantara and the purified water was pumped through syphons under the Suez Canal into masonry reservoirs on the east bank. From Kantara East a water supply main of 12 in., 10 in., and 8 in. steel screw-jointed pipes was laid into El Arish, in four sections, each about 24 miles long. Duplicate engines and pumps drove the water from the reservoir at Kantara to a reservoir at the end of the first section and thence it was again pumped forward through the next section of pipe and so on forward, section by section, until it reached El Arish.

To explain the work done on water supply it is necessary to describe briefly the system adopted for the distribution of water by rail and camel convoys and the clearest way to do this is to start from the beginning. Before the pipe-line from Kantara was laid and supplying water the Army had started on the march forward covering the railway construction parties and water had to be carried forward in trains of water trucks. These water trains were filled at a special siding, where 20 or more trucks could be dealt with simultaneously, and on arival at railhead, were emptied into a long row of canvas reservoirs laid beside the rails. Here, small camel tanks, called fantasses or fanatis, were filled up and these were carried forward by camel convoys for distribution to the troops beyond railhead. When the first section of pipe-line was completed a new water siding was provided and the railway was relieved of carrying water for the first stage and so on until water was finally pumped to railhead.

Once El Arish had been reached the army passed into a country where, within certain limits, the troops could be supplied with water from local resources. The railway engineers, however, rejected local water as unfit for use in its locomotives on account of its salinity and hardness; the railway, therefore, became the principal consumer of the piped supply; it was, however, also used by the troops to a considerable extent to supplement local supplies and in the final operations was a very valuable asset.

The army continued its advance from El Arish to Khan Yunis on a narrow front, along the caravan route, near the coast where the only water which can be found in the district is from wells in the sand dune area and in the villages of El Burj, Sheikh Zowaid, Rafa and Khan Yunis. At Khan Yunis two good wells about 100 ft. deep and at Beni Sela, an adjoining village on a higher site, a well 210 ft. deep were found. These three wells, when provided with pumps and engines, eventually supplied 130,000 gallons a day.

From Khan Yunis forward it became possible to extend on to a wider front, as water can be got in some parts of the bed of the Wadi Ghuzze and in its tributary valleys, from springs or in pools or by sinking shallow wells, while further to the right lay Beersheba whose wells have been famous since the days Abraham watered his flocks there. On the left front lay the village of Deir El Belah, with several good wells 20 to 30 ft. deep, the Wadi Ghuzze, and, further forward, the town of Gaza with abundant supplies of water from deep wells. The Turks abandoned to us Deir el Belah and Shellal, where the best supplies of water in the Wadi Ghuzze are found, but held on to Gaza and Beersheba.

For a time the army advanced no further but utilized the next few months in preparations and during this period much useful

work was done in the development of local supplies and in laying pipe lines forward and to the right flank to enable troops to be concentrated where required.

The railway was extended to Rafa and thence to Gamli, and Shellal on the right and to Deir el Belah on the left. The water from Kantara followed the railway to Rafa, in 6-in. and twin 4-in. pipes, and to Shellal, supplying the requirements of G.H.Q. and El Fukhari on the way. A pipe line was also laid from the wells at Khan Yunis, *via* Abasan el Kebir and Abu Sitta, to Abu Bakra and this was cross-connected from Abu Sitta to Abu Khatli so that water could be distributed either from Rafa or Khan Yunis to any point.

At Shellal, springs yielding about 14,000 gallons per hour of somewhat saline water, had been cleaned out, covered in, and the water was led through pipes to a water distributing area. A natural rock basin had been improved by a masonry dam and provided storage for some 500,000 gallons of water. A pipe line had been laid forward from Shellal to Imara, and three sets of 25 h.p. engines and centrifugal pumps were installed for local distribution and to pump waste forward if required. The capacity of each of these pumping sets was 4,800 gallons per hour against a 200-ft. head, and the pumps were arranged so that any two sets could work " in series " to pump against a 400-ft. head, keeping one set spare in reserve. At Abu Bakra several miles of piping were held ready to extend the pipe line beyond the Wadi Ghuzze if required. At Mendur and at Dorset House deep bore wells had been sunk and provided with pumping engines. The Deir el Belah wells were connected up and, from these, water was pumped into the trenches S. of Gaza, while further to the left there was another smaller piped supply from the Red House wells. Along the Wadi Ghuzze and in the sand dunes near the coast wherever water could be got, and was required, wells had been dug.

Between March and October, 1917, the force in this area gradually grew to three mounted divisions, a brigade of the Imperial Camel Corps, seven infantry divisions, and a composite brigade of Allied and Indian Imperial Service Troops. General Headquarters moved into the area in August 1917, and preparations were made for an enveloping attack on the Turkish position at Beersheba, combined with a frontal attack on Gaza.

In *Plate* I. an attempt has been made to indicate the arrangement of the water supply up to and during the operations which commenced on October 22nd.

The supply of water which could be brought into the area by rail and delivered at Shellal or Gamli was some 100,000 gallons. The El Arish-Rafa pipe-line, after meeting railway requirements at Rasum, could supply some 156,000 gallons per day to Rafa, whence

60,000 gallons per day could be delivered through Fukhari and Sheikh Nuran to Shellal or Abu Sitta. The Khan Yunis well and pumping station could supply some 100,000 gallons per day to Abu Sitta and thence by the cross line to Sheikh Nuran and Shellal, or direct to Abu Bakra. These transferable supplies from the rear, amounting to 260,000 gallons were controlled by General Headquarters during the course of the operations, and deliveries at the various watering points were regulated according to the daily movements of the troops.

The development of water supplies east of Esani was allotted to the Desert Mounted Corps, but could not be commenced until the date fixed for the first movement of troops into the area (Oct. 22nd). Preparations had to be made at once to collect suitable engines, pumps, and plant to restore and develop water supplies in an area which had not yet been occupied.

The development of water supplies in the Gamli-Shellal-Hiseia area, and east, including the improvements and restoration of the water supplies to Beersheba, when captured, was allotted to the 20th Corps, but no work east of the Wadi Ghuzze was to be taken in hand until October 22nd. The arrangements for the distribution of water in the Gamli-Shellal-Hiseia area, from which three mounted and four infantry divisions, accompanied by large convoys of camels for carrying water, were to start for the attack on the Turkish position, were of first importance. There is a considerable amount of water in springs and in pools in the bed of the Wadi Ghuzze within the limits indicated, but to make it available for rapid distribution involved a great deal of preparatory organization and work. At intervals along the valley a total of over 3,000 running feet of masonry and wood troughs were provided for watering horses and camels. In addition to the main road crossings, for use by transport, and roads for use of the troops moving out from the concentration area, special tracks across the Wadi had been arranged for animals going to and returning from water and others again for camel convoys carrying fanatis to and from the fantasse filling areas. All these roads were placarded with notice boards showing what formations had to use them, and where they led to.

At Shellal, a fantasse filling area, in which 2,000 fanatis could be filled and loaded on camels every hour, was organized, and the piping for the line to be laid forward, canvas tanks, watering troughs, and everything which was likely to be required for water distribution forward, were also collected here. At both Gamli and Hiseia pumping engines were erected to fill high level storage tanks, supplying water by gravity to fantasse filling areas, capable of filling 250 fanatis per hour.

The engines, pumps and plant for work in Beersheba had to be

collected, loaded on tractor trains and held ready to push forward without delay when the town had been captured.

The maintenance and enlargement of the water supply in the area Mendur to Sheikh Ajlin, on the sea, and back to Deir el Belah, was allotted to the 21st Corps.

Until October 22nd no troops or animals watered east of the Wadi Ghuzze. After this date troops began to move eastward to take up their position for the attack on Beersheba. The following is a brief summary of the work done between October 22nd and November 1st:—

DESERT MOUNTED CORPS.—*Abu Ghalyun* was occupied at dawn on the 22nd October, and work on water development started at once. An old well was cleaned out, but failed to produce a satisfactory supply. Work on a second well was started but was abandoned. Meanwhile an Officer of the Australian Engineers "divined" water in the Wadi bed not far away. Two wells, sunk at the places indicated by him reached an abundant supply of water at 13 ft. depth.

Malaga was occupied the same day and here trenches dug in the Wadi bed provided a good supply.

Khalassa was occupied by the Camel Brigade on the night of the 22nd-23rd and working parties started at dawn of the 23rd to restore two wells which had been effectively blown in by the enemy. These parties, relieved every two hours, worked continuously until finally the wells had been cleaned out to a depth of 42 ft. and 36 ft. respectively. Pumps and engines with a capacity of 4,500 gallons per hour were installed and water sufficient for a division of mounted troops was stored.

Asluj was occupied on the night of the 25th-26th October, and work started at once on the restoration of wells which the enemy had thoroughly destroyed. After a great deal of heavy work, including the installation of machinery, Asluj on the 30th was in a position to water a mounted division, Corps Headquarters, and a considerable concentration of friendly Arabs.

20TH CORPS.—*Esani* was occupied by one mounted brigade and one infantry brigade on the night of the 22nd-23rd October. A party of 1,000 men of the Egyptian Labour Corps accompanied this force for work under the R.E., and work began on the morning of the 23rd. The source of water supply was springs and pools in the Wadi bed. Two portable power-driven pumping sets with a combined capacity of 8,000 gallons per hour, canvas storage tanks with a capacity of 150,000 gallons, and water distribution gear, were installed. 200 wood horse troughs filled by lift and force pumps were also provided in the Wadi bed. Work was completed within three days when a yield of 100,000 gallons per day had been attained.

Imara.—On the 25th October storage capacity for 80,000 gallons was erected at Imara and the water was pumped forward to Imara from Shellal.

Karm.—Work on the pipe line from Imara to Karm was started on the 23rd. On this day five kilos. of pipe were laid out and screwed up in ten sections. On the 24th these ten sections were connected through, the pipe was tested and washed out, and storage tanks and distribution arrangements were completed at Karm. During the night of the 24th-25th the water was being pumped from Shellal through Imara to Karm and was available on the morning of the 25th for the use of the troops. Later, additional storage and second water distribution areas were provided at Karm for water brought by the rail from El Arish, and when the railway extension had been completed 80,000 gallons per day were delivered for some days.

Khasif.—At Khasif the cisterns were cleaned out and filled with 60,000 gallons of water, carried there by two camel convoys of 1,000 camels each on the 29th and 30th October. This provided an additional advanced reserve of water.

The water problem at Beersheba, after its capture, was not confined to the immediate provision of water sufficient for the minimum daily needs of the Cavalry Corps and two Infantry Divisions, in itself a large order, but it was necessary, with as little delay as possible, to make such preparations as would allow the second phase of the operations to begin. This could only happen when it was possible for the force to march out with a day's ration of water in hand for troops, and every animal to drink its fill before starting. The water question ahead of Beersheba was, at best, a doubtful one, and it was essential that when the advance from Beersheba began, the force employed should be in a position to face a long waterless period.

The Turks only destroyed a few of the wells before leaving, though all the principal wells had been prepared for demolition. This neglect, while most fortunate for us, was not creditable to the Turkish Engineers, for, however sudden the attack, it was only the work of a moment to light the fuses which were ready in position. Of the 17 wells in Beersheba, only two were thoroughly demolished, and two partly damaged. In three wells the pumps were in a workable condition though the engines had been put out of action. In three other wells, saqqias * were found in at least a workable condition, and though two of these saqqias were discarded as unprofitable and replaced by pumps and engines, the third was put in good working order in a few hours and was able to cope with the full yield of the

*A saqqia is a wheel fitted with buckets for raising water. It is worked as a rule by an animal pacing round in a circle on the principle of the old-fashioned mill.

well. In addition the Turks had left intact two reservoirs containing some 90,000 gallons, a very useful legacy.

It was at once clear that the source of water in Beersheba was a large one and likely to provide nearly the whole need of that part of the force which was temporarily based on the town—a force requiring in all about 400,000 gallons per day. It was not to be expected that this volume of water would be available at once but horses can subsist without water for 48 hours, and men can do with less than a gallon per day if the weather is at all favourable as one might hope it would be in the beginning of November.

However, the three or four days after the capture of Beersheba were among the hottest of the year—a strong "khamseen" wind blew without intermission, and the whole of the district was enveloped in fine dust.

Of the plant carried by the tractor train five engines and three pumps were erected and parts of the sixth engine were used to replace similar parts in a duplicate engine left by the Turks. The three pumps left by the Turks were put in good working order. Four pumping sets brought in from Asluj were erected, one saqqia was put in order and used continuously and from two wells water was raised by bucket and rope. Several of the wells were concealed in houses and gardens; two were not found until the third day and one on the fourth day.

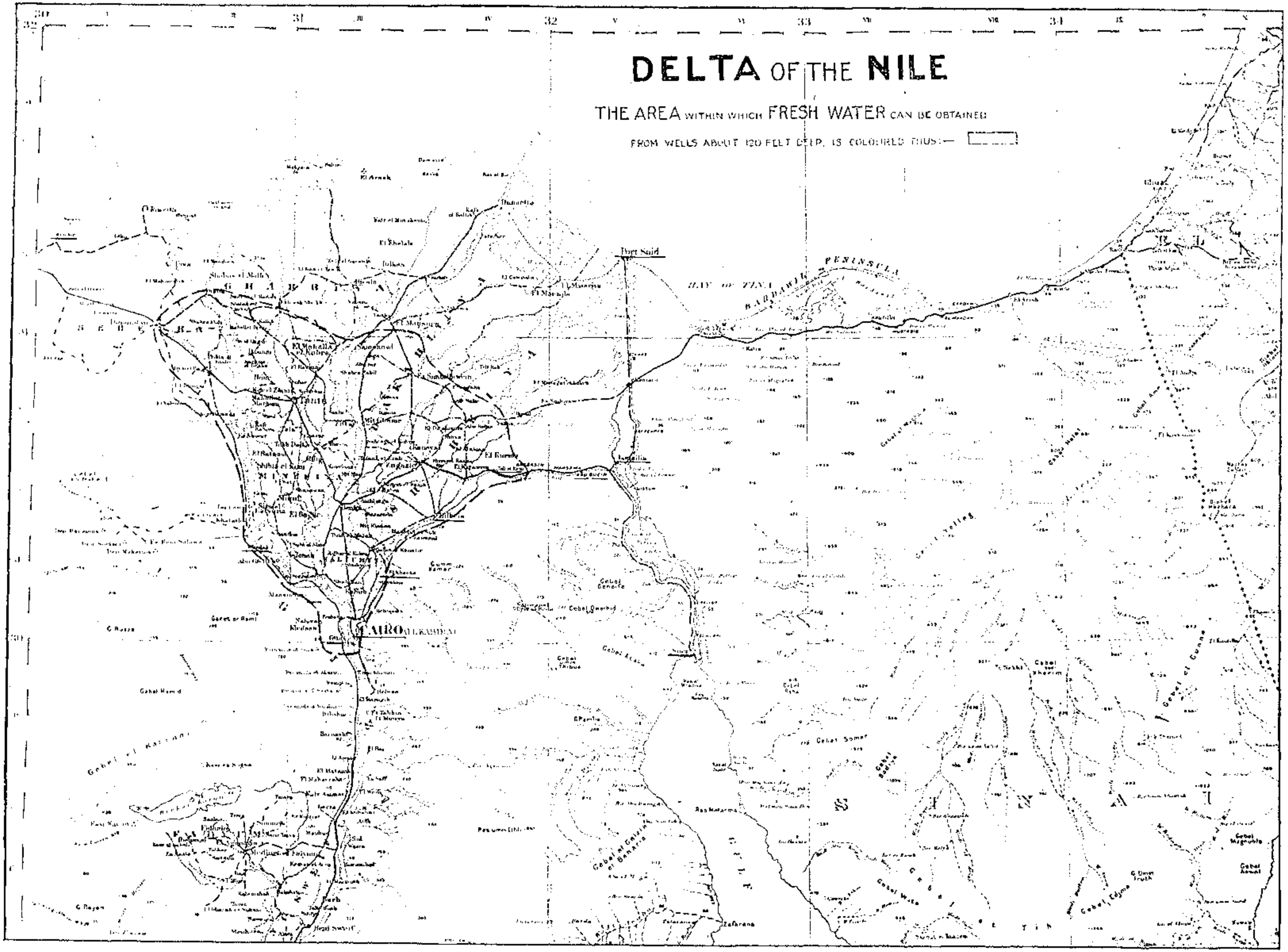
On the third day, in the afternoon, the water situation was most acute. Every available gallon of water stored during the previous night having been consumed. The output was just equal to the demand, and it was expected that watering animals for the day would be finished by midnight. At 1600 a Mounted Brigade of some 2,000 men and horses, with 48 hours thirst, arrived unexpectedly. A new well, with saqqia, had fortunately been found about noon n this day, the saqqia was being repaired and troughs were being erected, but there was no means of knowing what the yield of the well would be. This well was at work by 1700 and proved a good one, yielding about 1,500 gallons per hour, just enough to provide water by midnight for the Mounted Brigade.

During the first two days some water had been found in shallow pools and in pits dug in the wadi bed to the west of the town. This supply, however, was nothing more than surface water left from a storm which had occurred about a week before, and it was soon exhausted. By the morning of the fourth day the water development had reached its maximum, the total output was about 390,000 gallons per day, and after this there was no further great anxiety.

As an extreme measure an attempt was made to cut down the ration of water to horses by imposing a time-limit for each batch of horses as it came to the troughs. Such rationing might be

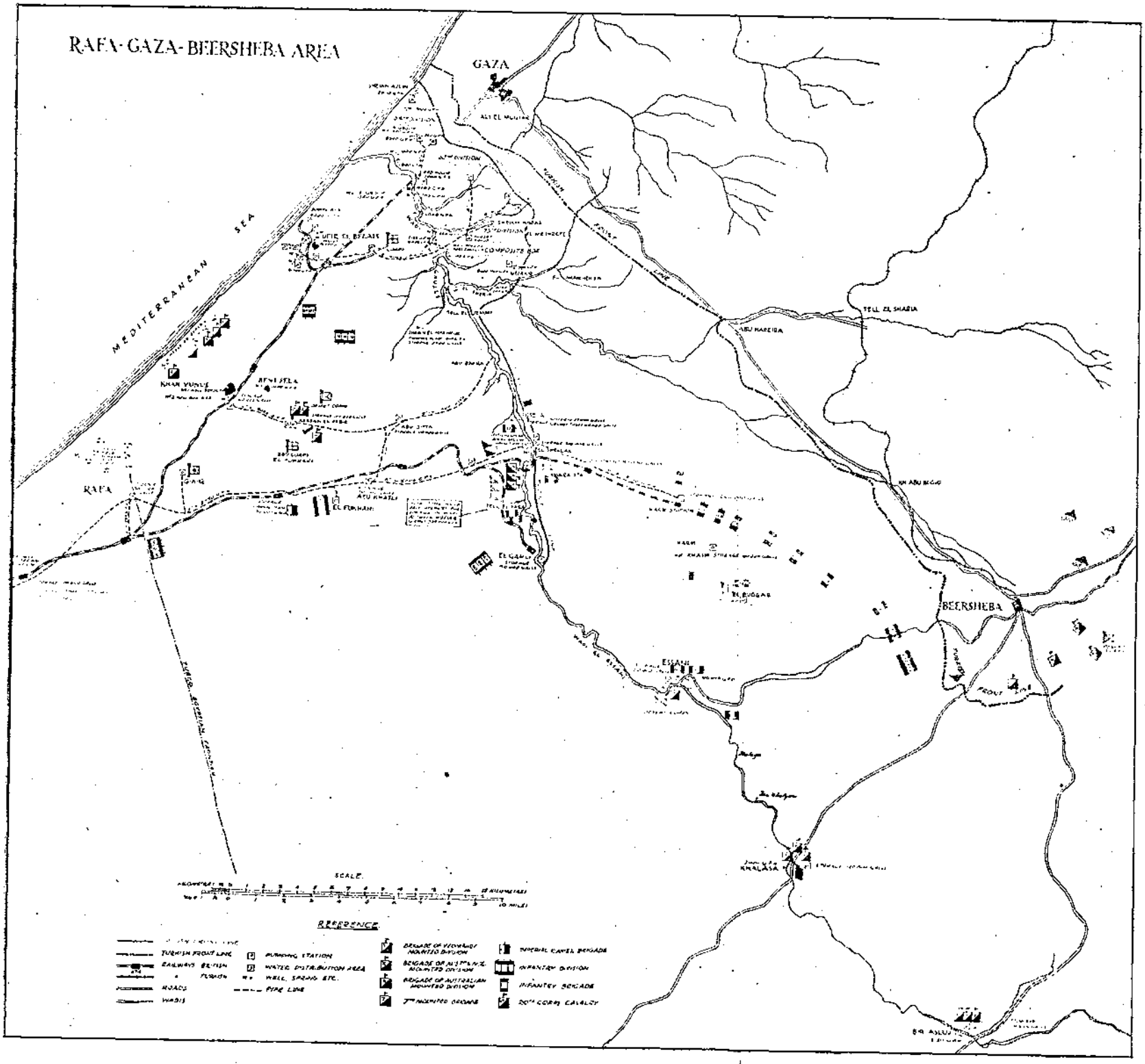
effective where the control of the watering area was very perfect, and where animals had not been without water for an undue time. In the exceptional circumstances at Beersheba, the famished horses got out of control and rushed the troughs as soon as they got near them, and then while some drank greedily, it was a difficult matter to get others to drink. There is no difficulty in limiting the ration of water for camels as the camel habitually drinks in two "bouts" with an interval of about 10 minutes. Every line of troughing was provided with a stout guard rail. This was well worth the extra time and labour, as it prevented animals from breaking down the troughing in their eagerness to drink.

PLATE II.



DELTA OF THE NILE
THE AREA WITHIN WHICH FRESH WATER CAN BE OBTAINED
FROM WELLS ABOUT 120 FEET DEEP, IS COLOURED THUS:—
Port Said
PENINSULA
CAIRO
Ismailia
Suez
Gebel Geneife
Gebel Ataka
Gebel Somar
Gebel et Tih
Gebel Hamid
Gebel el Katrani

PLATE I.


RAFA-GAZA-BEERSHEBA AREA
GAZA
MEDITERRANEAN SEA
KHAN YUNUS
RAFA
EL FUKHARI
TELL EL SHARIA
ABU HAREIRA
BEERSHEBA
KHALASA
SCALE
REFERENCE

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

OFFICIAL records are in course of preparation under the above title. The work is of a comprehensive nature, as will be seen from the following proposed synopsis, which is, of course, liable to alteration :—

PROPOSED SYNOPSIS.

Part I.—General. Development of the Corps. Causes that led to the formation of new branches and units. Charts to show organization and strength of the Corps in August, 1914, and Nov., 1918, etc., etc.

Part II.—Work under the Director of Fortifications and Works.

Part III.—Work in the Field under the Engineer-in-Chief, B.E.F.

Section 1. General.
" 2. Engineer Intelligence.
" 3. Defences.
" 4. Bridging.
" 5. Water Supply.
" 6. Machinery, Workshops, Electricity.
" 7. Mining.
" 8. Geology.
" 9. Inundations.
Section 10. Camouflage.
" 11. Anti-Aircraft Searchlights.
" 12. Foreways.
" 13. Concrete Factories and Defences.
" 14. Experimental Section.
" 15. Hutting and Encampments.
" 16. Schools.

Part IV.—Work in the Field under other Branches of the Staff (France).

Section 1. Maps.
" 2. Gas Services.
" 3. Forestry.
Section 4. Postal Section.
" 5. Meteorological.

Part V.—Work in the Field in other Theatres of War.

Section 1. Egypt.
" 2. Gallipoli.
" 3. Mesopotamia.
" 4. Salonika.
Section 5. W. Africa.
" 6. E. Africa.
" 7. Miscellaneous.

Part VI.—Work under the Director of Works (France).

Part VII.—Work under the Director-General of Transportation.

Part VIII.—Supply of Engineer Stores and material.

With the authority of the Director of Fortifications and Works the *R.E. Journal* will publish certain sections of these reports as they may become available. It is probable that they will be issued later in separate volume form, and in order that the final issue may be as complete and correct as possible, it is hoped that readers with special knowledge of any of the subjects will freely criticize the work.

It will be a convenience if such criticisms with proposals for amendments or additions are sent as early as possible to the Secretary, R.E. Institute.

In the present number of the *R.E. Journal*, Part III., Section 11, "Anti-Aircraft Searchlights," and Part IV., Section 4, "Postal Section," are published.

ANTI-AIRCRAFT SEARCHLIGHTS.

PART III., SECTION II.

SUMMARY OF DEVELOPMENT OF ANTI-AIRCRAFT SEARCHLIGHTS, FRANCE, 1915—1918.

1. *Resources in* 1915.—In 1915 the anti-aircraft searchlight resources available in the British Expeditionary Force consisted of Nos. 1 and 2 Anti-Aircraft Searchlight Sections with fixed equipment of three 60-centimetre projectors each. These were employed for the protection of General Headquarters at St. Omer, which was twice bombed during the winter of 1915—1916.

It is reported that on one occasion an enemy aeroplane was picked up and held in the searchlight beams for about half a minute during this period.

At this time night bombing by aeroplanes was practically unknown, and only bombing by airships was anticipated, for which the 60-cm. searchlights would have been sufficiently powerful.

2. *Additions, March—May*, 1916.—Between March and May, 1916, the following additional resources became available:—50th (Field Searchlight) Company, R.E. (Mobile), (comprising one section of two 90-cm. lights, and two sections of one 90-cm. and one 60-cm. light each); Nos. 3 to 7 Anti-Aircraft Sections, R.E. (with three fixed 60-cm. equipments each); and these resources were distributed as follows:—

1 section of the 50th (F.S.L.) Company,					Boulogne.
1	,,	,,	,,	,,	Audruicq.
1	,,	,,	,,	,,	Advanced G.H.Q.
No. 1 A.A.S.S., R.E.,					G.H.Q., 1st Echelon.
,, 2	,,				G.H.Q., 2nd Echelon.
,, 3	,,				Calais.
,, 4	,,				Abbeville.
,, 5	,,				Etaples
,, 6	,,				Rouen.
,, 7	,,				Abancourt.

3. *Bombing of Audruicq Depôt, July*, 1916.—On the night of the 22nd—23rd July, 1916, several enemy aeroplanes bombed the Audruicq Ammunition Depôt.

Only two lights of the 50th (F.S.L.) Company and two anti-aircraft guns were available at Audruicq at the time of this raid, and they were unable to render effective assistance in defence owing to the fact that the lights on the ground might have disclosed the position of an ammunition train which was being loaded. Subsequently to the dropping of the first bomb, however, the aiming became wild, and the bombs were mostly directed against the searchlights themselves.

4. *Searchlight in Observation Balloon, Somme, 1916.*—During the first Somme Battle experiments were carried out at the front by No. 2 Section of the 50th (F.S.L.) Company and No. 1 Kite Balloon Squadron, Royal Flying Corps, with a view to mounting a searchlight in an observation balloon for the purpose of illuminating the ground. This was successfully accomplished, but the balloon itself was found to be so unsteady that accurate estimation of direction was impossible.

A new form of searchlight developed by the Royal Navy, and for which a much increased light intensity was claimed, was tested at the front by the 50th (F.S.L.) Company, and efforts were made to employ searchlights to assist infantry and artillery in active operations, but no opportunity presented itself during the battle.

5. *Bombing on Somme Front, September, 1916.*—About September, 1916, hostile bombing by aeroplanes by night began to develop in forward areas, particularly on the Somme Battle line along the Maricourt Plateau.

Machine-gunning of the roads by enemy aircraft also commenced in this area towards the end of the autumn, 1916, and as a countermeasure Nos. 2 and 5 Anti-Aircraft Searchlight Sections were ordered to the area between Montauban, Trones Wood, and the Somme. These lights were placed under the XIV. Corps Heavy Artillery, and did excellent service in forcing enemy aircraft to fly at considerable heights, and in vastly reducing the damage done. Very few targets were actually detected in the beams, however, and this fact is accounted for by the unsuitability of the equipment available, and the excessive local noises due to gunfire and transport in the forward areas, together with the inexperience of the detachments.

6. *Bombing subsequent to Somme Battle.*—Subsequently to the Battle of the Somme continuous hostile air raids were made by night along the whole of the Somme valley extending as far as Amiens.

No. 2 Section of the 50th (F.S.L.) Company, together with Nos. 2 and 5 A.A. Searchlight Sections, were allotted to this locality, and it was credibly reported, but not officially confirmed, that one enemy aircraft was shot down in the searchlight beams on the night of the 8th—9th February, 1917.

The detection of enemy aircraft in the beams was, however, an unusual occurrence at this period owing to the causes mentioned in paragraph 5 above.

7. *Reorganisation of A.A.S. Units.*—By this time Nos. 8 to 18 A.A. Searchlight Sections had gradually arrived from England, and Nos. 21 to 24 had been formed in France. These units were mainly allotted for the defence of large ammunition depôts then being formed at Audruicq, Zeneghem, Saigneville, Abancourt, and Dieppe, whilst No. 8 Section was sent to protect the Second Army Ammunition Dump between Abeele and Poperinghe.

At this period all the A.A. Searchlight Sections were reorganised on

a basis of two lights each, because owing to the scarcity of resources it was found possible to allot only one section to any one place, and the triangle formed by three lights was generally subjected to bombing.

The various local staffs responsible for the siting of the lights did not understand their use, with the result that the searchlights usually surrounded the position to be protected, and were in consequence apt to become more of a danger than a protection.

The retreat of the enemy from the Somme Battlefield afforded an opportunity of using searchlights as a means of illuminating bridge building operations at night, and valuable work of this nature was carried out by the 50th (F.S.L.) Company at Brie-sur-Somme.

8. *Institution of Office of Inspector of Searchlights.*—In January, 1917, the Office of Inspector of Searchlights under the Engineer-in-Chief, G.H.Q., was constituted to assist in the formation and training of the units, and to advise the various staffs on the disposition of the resources.

Late in 1916 the provision of a total of 45 two-light sections had been formally approved by the War Office, and it was reported that the 60-cm. lights were not effective, with the result that the War Office authorised an entire re-equipment with 90-cm. projectors.

To save delay the *personnel* for the new units was sent to France without equipment, and this was eventually provided as it became available from England, through the agency of an equipment depôt established under the Inspector of Searchlights at Calais. The 90-cm. equipment to replace the existing 60-cm. plant was dealt with through the same depôt.

9. *Development during the Spring of* 1917.—During the spring of 1917 enemy aircraft attacks were mostly confined to the Audruicq and Calais areas.

In the former case the attacks were all unsuccessful owing to the improved anti-aircraft defences.

This period and the early summer of the same year were devoted to the training of the new *personnel*, equipment of the units, and co-operation with anti-aircraft artillery.

A mechanical control for the searchlight projectors was developed without which the useful action of the lights would have been almost impossible. By means of this device the projector controller was situated some 12 to 14 feet from the projector itself, and was thus able to see the target in the beam.

10. *Bombing during Summer of* 1917.—During the early summer of 1917 enemy aircraft extended their attacks to the Isbergues Steel Works, Arras, St. Omer, Audruicq, Calais, and the Second Army area. The searchlights had by this time begun to detect and hold enemy aircraft in their beams, but still further experience and training were required to make the *personnel* throughly efficient. In July, August, and September, 1917, very heavy night bombing was

experienced in the XV. Corps area on the coast behind Nieuport, and in the Second and Fifth Army areas in the third battle of Ypres. Two sections of 50th (F.S.L.) Company, and fourteen A.A.S. sections were accordingly concentrated in this area.

The lights thus concentrated then began to work with great efficiency, and in spite of the misty atmosphere prevailing in this low-lying country it is reported that between 50 and 60 per cent. of raiding aircraft were detected and held in the beams. Several enemy aircraft were destroyed by anti-aircraft gunfire, and many were driven off.

All enemy aircraft were forced to fly at heights of 6,000 to 12,000 feet, with the result that the casualties were reduced to the minimum which might be expected from indiscriminate bombing of a large area.

11. *Lighting of Ypres Area.*—The use of lights in the forward area was then developed on a line between Ypres and Brielen. The searchlights themselves were very severely bombed, and the provision of suitable earthwork protection for the *personnel* was perfected. Eventually, although casualties were still caused by shell fire, the efficiency of the earthwork protection was such that no casualties were caused by the effect of bombs when the men were actually under cover.

The detachments showed great determination and courage in keeping the searchlights directed on to enemy aircraft whilst being heavily bombed, a result which there is evidence to show the enemy were never able to achieve in their own anti-aircraft defences.

12. *Lighting of Bethune Area.*—In the autumn of 1917 the Isbergues Steel Factory and the Bethune area were consistently bombed, and four A.A. Searchlight Sections were allotted for the protection of this locality.

The action of the lights was not entirely effective owing to the fact that they had to be scattered in an effort to cover the whole area, whereas in this very misty locality close concentration was essential for effective operation. Enemy aircraft, however, rarely flew at lower altitudes than 10,000 feet.

Throughout the year attacks on Audruicq and Zeneghem were continually being made, but the anti-aircraft defences were sufficient to prevent any serious damage being done.

13. *Reorganisation Committee.*—During this period the whole question of anti-aircraft protection again became pressing, with the result that a G.H.Q. Committee was formed with representatives of Major-General Royal Artillery, Engineer-in-Chief, Director of Signals, Royal Flying Corps, and Machine Gun Corps.

This Committee took evidence at Army Headquarters from all who wished to express their views. Army Commanders, Corps Commanders, Divisional Commanders, General Officers Commanding R.F.C. Brigades, Directors of Signals, General Staff, and M.G.R.A.,

were examined, with the result that a comprehensive report was made, containing recommendations as to the lines on which anti-aircraft development should proceed. An increase of 30 anti-aircraft sections was authorised as an initial measure. Owing, however, to the shortage of men at the time it was found possible to provide only about 30 per cent. of the additional *personnel* (men of medical category "A") from England, the remainder being found in France from category "B" *personnel* transferred from the infantry, and trained in the existing A.A. Searchlight Sections.

Authority was subsequently given for the addition of a third light to each Anti-Aircraft Searchlight Section then approved, the *personnel* being found partly from "A" men from England and partly from "B" men transferred from infantry in France.

As a further result of the G.H.Q. Anti-Aircraft Committee an Assistant Inspector of Searchlights with the rank of Major was authorised for each army, and for L. of C., with the rank of Captain.

14. *Progress of Expansion of Lights.*—The expansion to provide an additional 135 lights was in progress during the whole of 1918, and the Inspector of Searchlights arranged to form the whole of the 30 new A.A. Searchlight Sections referred to above by withdrawing experienced N.C.O.'s and men from the older sections in France, and by the dilution of the establishments with category "B" men. This operation, which then became universal, entailed much work in connection with equipping and training the new sections.

Simultaneously, twelve additional 3-light sections were authorised for the protection of the aerodromes of the Independent Air Force, none of which became available, however, before the Armistice.

15. *Employment of First Night-fighting Squadron, R.A.F.*—In the autumn of 1917 it had been foreseen that it would be necessary to use night-fighting aeroplanes to attack enemy aircraft, and a letter had been put up through the Engineer-in-Chief and General Staff to the Royal Air Force requesting that this should be arranged. About June, 1918, No. 151 (Night-Fighting) Squadron, R.A.F., became available for employment with the anti-aircraft resources in the B.E.F. This squadron was at first used in connection with a series of outpost lights in front of Abbeville, but the experiment was unsatisfactory owing to the fact that the area was not sufficiently extensive, and very few combats were reported.

Several more night-fighting squadrons had been authorised, only one of which became available before the Armistice.

16. *Provision of Mobile Generating Sets.*—At the time when the proposal for night-fighting squadrons was put forward it was decided to ask that all additional searchlights should be 120-cm. projectors. Further, the provision of mobile searchlight equipments previously vetoed, had by this time been proved to be absolutely necessary, and all additional equipments were accordingly made mobile by the introduction of petrol-electric lorries.

These mobile generating sets are of a complicated and highly technical nature, and it was considered advisable to select, and train, as drivers, suitable men from amongst the skilled mechanics in the Searchlight Sections. This training was carried out in France.

17. *Forward Area Bombing, February*, 1918.—During the winter of 1917 enemy bombing at night had been slight, but about February, 1918, heavy bombing began to develop in the Third and Fifth Army areas, where the 50th (F.S.L.) Company, and 14 A.A.S. Sections were then concentrated.

The forward areas thus covered were full of troops and horse lines concentrated in anticipation of attack by the enemy.

The action of the lights and guns was so effective that enemy aircraft rarely penetrated the areas, with the result that the casualties were comparatively small. In some cases the searchlights were able to pick up every enemy aircraft which approached the area.

18. *Defence of Railway Junctions, March*, 1918.—In March, 1918, when it became evident that attack by the enemy was impending, anti-aircraft protection was hastily improvised for the important railway junctions at Hazebrouck, St. Pol, and Doullens as follows :—

Two A.A.S. Sections at Hazebrouck.
Two A.A.S. Sections at St. Pol, and
Four A.A.S. Sections at Doullens.

19. *Bombing during German Advance, March—April*, 1918.—During the battles of March and April, 1918, forward areas in the First, Third, and Fifth Armies were heavily bombed, and owing to the fact that most of the lights in these areas were fixed, 14 sets of equipment were captured by the enemy, during his advance.

Such mobile equipments as were available were maintained in action continuously within 2,000 to 5,000 yards of the line, and particularly in front of Amiens, Albert, and Isbergues. These lights rendered very valuable service in co-operation with the anti-aircraft artillery.

The railway junctions referred to above were heavily attacked, but the anti-aircraft protection was apparently a surprise to the enemy, and his action was so much hampered that no serious damage was done to these vital points.

20. *Bombing of Bases, etc.*, 1918.—During April and May, 1918, heavy attacks were made on Abbeville, Abancourt, Etaples, Boulogne, Calais, and Audruicq.

Except in the case of the last mentioned, where considerable resources were available, great damage was caused, and this is attributable to the fact that the anti-aircraft defences were entirely inadequate.

During, August, September and October, the First, Third and Fourth Army areas were heavily bombed, and A.A. Searchlight Units were accordingly distributed as follows :—First Army, 9

Sections; Third Army, 5 Sections; Fourth Army, 50th (F.S.L.) Company, and 5 Sections.

21. *Organisation of Lighted Belt on New Front.*—A captured German document shows that the enemy reported very heavy bombing on the troops, etc., assembled in the Anzac Corps area in the Hallue Valley on the night of 21st—22nd August, 1918.

The searchlights had, however, been pushed up in front of this area on the night previously, so that the bombs fell in advance of the troops and no damage was caused.

Subsequently all available lights were pushed as far forward as possible, the foremost line being from 2,000 to 6,000 yards from the trenches, and eventually the lighted belt was extended along the whole front and provided with rows of searchlights two, three, and four deep.

No. 151 Squadron, R.A.F., working in conjunction with this belt of lights were able to destroy in flames some 25 enemy aircraft on our side of the line, with the result that in the end the bombing was limited to the areas in front of the foremost line of searchlights, the back areas being almost completely immune.

Severe casualties were caused in places where lights were not available, but the gaps in the lighted belt were closed as soon as practicable by new units hastily formed as the equipment arrived from England, or by old units from L. of C. which had been replaced by newly formed sections; and eventually the casualties from hostile night bombing were reduced to a minimum.

Lights were frequently in action at the front within two or three days of their arrival at Calais from England.

22. *Use of Lights during Final British Advance.*—The general retreat of the enemy during the closing stages of the war again afforded opportunities to utilise searchlights for illuminating bridge building operations at night, and much valuable work of this nature was carried out.

It was also reported that the lights had been used in the forward area near Mons in connection with railway construction work. One searchlight had been placed at each end of a mile of railway track, and the beams aligned at an angle of about two degrees elevation over the working parties. By this means the whole length of track between the two searchlights was illuminated sufficiently for the parties to work at night.

From time to time during the course of the war the lights have, in addition, been used to assist in trench raids and other minor operations as recall signals and aids to direction.

23. *Anticipated Development if War had gone on.*—An additional sixteen 3-light sections had been approved in the late autumn of 1918, and were almost ready for action at the time of the Armistice.

If the war had gone on, an illuminated barrier, four lights deep, would have been established down the whole British front, and it is

believed that the anti-aircraft defences in back areas could then have been considerably reduced, with the exception of those in the area between Calais and the line.

It is thought that the efficient sound locators, suitable night binoculars, and more powerful searchlights which had become available, in conjunction with the high standard of training attained by all ranks, would have rendered the searchlights capable of dealing successfully with enemy aircraft at whatever height they might have flown in the future.

24. *Personnel of A.A.S. Sections.*—The *personnel* with anti-aircraft searchlights, which amounted to some 3,000 all ranks at the end of active operations, was found very largely from the London Electrical Engineers and the Tyne Electrical Engineers, with a proportion of regular Royal Engineers, and about 600 men of medical category "B" transferred from the infantry.

25. *Training of American Units.*—During the course of 1918 over 1,000 officers and other ranks of the American Engineers were attached to the British Searchlight Units in Army areas for instruction, pending arrival of the American technical equipment. This *personnel* co-operated very closely with the British detachments, and the increased numbers thus available were of the greatest assistance during moving warfare, which necessitated much work in moving heavy weights and digging earthwork protection. On return to their own army the American *personnel* thus trained were very soon able to render effective service with their own equipment during the course of the battles in which the American Army was engaged.

An Anti-Aircraft Company of Canadian Engineers, consisting of 12 mobile 90-cm. projectors was formed in July, 1918, and rendered good service; and had the war been prolonged throughout the winter of 1918, it is probable that the Australian Corps would also have formed an Anti-Aircraft Searchlight Company from Australian Engineer *personnel*.

26. *Conclusion.*—Experiences in France have shown that an Anti-Aircraft Searchlight Detachment requires the best equipment, a high standard of training, and, wherever possible, complete freedom in control of action. An elaborate system of "central control" such as has sometimes been found necessary in connection with the defence of large ammunition depôts, has undoubtedly hampered the working of the lights in action; and it is therefore suggested that they should be developed independently of the anti-aircraft artillery, as their work in the future will lie more and more in co-operation with night-fighting units of the Royal Air Force.

POSTAL SECTION.

PART IV., SECTION 4.

ARMY POSTAL SERVICES.—ROYAL ENGINEERS SPECIAL RESERVE (POSTAL SECTION).

1. *Introduction.*—It has been accepted as an axiom that the effect of a good postal service upon the *morale* of the troops is of inestimable value.

The manual of Army Postal Services, revised in 1913, lays down the elementary principles governing the Postal Service of an Army in the Field. These principles have in the main amply stood the test of experience, although the proportions which the service assumed in the war necessarily led to considerable amplification of the original machinery.

2 *Initial Operations.*—As will be seen from the Appendix the original establishment of the Postal Section of the R.E. Special Reserve was extremely small. The Postal Units comprised :—

1 Base Office.
1 Advanced Base Office.
2 Stationary Post Offices.
1 Field Post Office with General Headquarters.
1 Field Post Office with H.Q. Inspector-General of Communications.

Divisional Offices.

Field Post Office with each Divisional Headquarters.
Field Post Office with each Brigade Headquarters.
Field Post Office with each Divisional Train.

The advance parties of the Base and Advanced Base Post Office Staffs embarked for France on the 11th August, 1914, followed by the remainder on 15th August.

The Field Postal Units proceeded with the formations to which they were attached.

The Base Post Office was established at Havre, and the Advanced Base Post Office at Amiens.

On the 27th August, owing to the retirement of the forces after the battle of Mons, the Advanced Base was transferred from Amiens to Rouen, and a few days later to Le Mans, the base having been moved to Nantes in the meantime.

The fortunes of the Postal Service in the field during the retirement followed those of the army generally. Such business as came to hand

circulation could be secured. Up to the end of November, 1914, the absence of railway facilities suitable for such purposes, and the lack of mechanical transport on lines of communication and between formations in the field, gave rise to great difficulty.

The railway supply routes, while serving for the transmission of mails from the bases to railheads, were of no use for "cross-post" services. Road services were accordingly organised. These services were not of course stable in nature; they changed daily with the varying incidence of troops movement, and unquestionably the most difficult problem with which the Army Postal Service had to deal, was the maintenance of a vast system of interwoven road and railway services which at any given time, and under any circumstance incidental to warfare could be relied upon to ensure the speedy transmission of correspondence between one portion of the army and another. It is estimated that at the peak of the traffic as many as five millions of letters a week, official and private, were so dealt with, and it is claimed that speaking generally the normal time occupied in transmission of a letter from one part of the line to another, or to and from the L. of C. (excluding of course the more distant points, *e.g.*, as Marseilles, Taranto, etc.) was 24 hours.

6. *Development of Army and Corps Troops Services.*—Up to about the middle of 1916 Stationary Post Offices existed only on lines of communication. The development of the military situation, however, involved the emplacement of large numbers of extra Army and Corps Troops (such as heavy and siege artillery, labour companies, tunnelling and road construction companies) of a semi-stationary nature in army areas. On one army front alone there had grown up by July, 1917, extra troops of this description equivalent to the population of the town of Southampton, and the mobile post offices attached to headquarters of field formations were unable to cater for these vast agglomerations.

Post offices of a semi-stationary character were accordingly established in army areas for the purpose, and it would be no uncommon thing for an office of this description to receive from 400 to 500 bags of mail and despatch some 30,000 letters daily in addition to large transactions in postal orders, war savings certificates, and registered letters.

7. *Accommodation.*—The provision of accommodation for post offices, particularly in the devastated areas, afforded opportunity for the exercise of considerable ingenuity and architectural fancy. It would sometimes take the form of a regulation hut, or collection of huts and tents, but more often than not shift would be made with a ruined building, an abandoned "dug-out," or even a few tarpaulins more or less effectively draped over a structure of old biscuit boxes or petrol tins. But few standard fittings existed,

was transacted by the Field Post Offices attached to the various headquarters, but owing to the change of base, no mails could be sent forward to the troops at the front for more than a week.

At the time of the first battle of the Aisne the Advanced Base of the Army Postal Service was at Livveneuve St. Georges (near Paris), and as the position stabilized arrangements were made to re-establish the Postal Base at Havre with a regular service from Southampton. This was brought about on the 28th September, and a marked improvement was effected at once. On the 14th October the Advanced Base moved forward to Abbeville.

At the beginning of October, 1914, an Auxiliary Postal Base at Ostend was established to serve the portion of the army operating in Belgium, but military events precluded the use of this base for more than a few days.

3. *Christmas* (1914) *Traffic.*—The first Christmas presented a serious traffic problem. There was no previous experience to go upon, and it was impossible to form any estimate of what the volume of mail matter was likely to be; moreover the resources in the matter of staff and transport were extremely inelastic. In anticipation, however, of a very large increase the staff was temporarily increased from 900 to 1,500, and 50 additional motor lorries were obtained from England. The actual increase was about 90 per cent. in letters and 345 per cent. in parcels.

4. *Improvements in* 1915.—In the new year, 1915, several important improvements were effected having for their object the acceleration of the mails both to and from England.

It became clear that the growth of the army, coupled with considerations of transport precluded the maintenance of a base sorting office for English letters and parcels in France for any lengthy period. The only solution was the complete sorting of the mails in England, thus admitting of the diversion of those for any particular unit to any port, the work in France being limited to the distribution of the unit bags received from England and to "cross-post" (intercommunication) and local traffic. Arrangements were therefore made for a gradual transfer of the English sorting work to the Army Postal Depôts in London. By the 8th February this had been accomplished, and the whole of the mail traffic transferred to the Boulogne route. Later on provincial concentration offices in England were established as auxiliaries to the London depôts.

At a later stage it became necessary, owing to the growth of the army and for transport convenience, to divide the cross-channel traffic between Boulogne, Calais, and Havre.

5. *Inter-communication Services.*—The enormous growth of postal inter-communication between the various parts of the army necessitated the setting up of machinery by means of which expeditious

except at the large permanent depôts; canvas sorting racks and various tin boxes formed part of the equipment, but it was generally found convenient to improvise fittings from local resources which could be "scrapped" on evacaution.

It may not be out of place at this point to quote the following extract from an article in the *Daily Mail* of the 22nd September, 1918, from the pen of John Pym, entitled "The Black Box," which provides a graphic and accurate picture of the mobile field post office.

"A Field Post Office is primarily an iron box—not a building; a black, heavy box, under the care of a corporal and two sappers. The box holds postal orders, stamps, cash, lead seals for mail bags, rule books, and scores of other items—not forgetting the red-and-white flag of office. This box may be lodged anywhere—in an open field, a barn, a stable, a tent, cellar, dug-out, or a chateau; but wherever it is dropped there is the field post office."

8. *Organisation of Directorate.*—At the outset the directorate comprised a director and deputy director at Headquarters, with assistant directors with each Army Corps. Later on assistant directors were appointed at the headquarters of each Army with deputy assistant directors with each Army Corps, and the whole service was sub-divided for purposes of administration into two sections, each under a deputy director, as follows:—

Northern—including the northern armies, ports, and lines of communication.

Southern—including the southern armies, ports, and lines of communication

Assistant directors were appointed to H.Q., L. of C., and at the Base Ports.

With each division was a warrant officer, who was responsible under the deputy assistant director at Corps Headquarters, for the whole of the internal postal organisation of his division.

9. *Cross Channel Services.*—The ordinary mail boats were used up to their fullest capacity at all the ports, cargo boats and transports being used for the conveyance of the surplus parcel mails.

The volume of mails dealt with at the different ports varied from day to day according to the geographical distribution of the troops, and to the requirements of railway traffic.

10. *Distribution of Newspapers, Letters, and Army Publications, and Stationery by Express Road Services.*—A branch of the work of the Army Postal Service which was regarded as of great importance to the welfare of the troops was the distribution of newspapers.

Subscribers' newspapers which could not be posted in London in time for inclusion in the mail bags were sent out in bulk to Boulogne

with the mails, and there sorted and included in special express despatches. These express services were provided by a number of lorries which left Boulogne about one hour after the arrival of the Mail Packet. In addition to the afore-mentioned despatches they carried the letter mails from England for the headquarters of all formations in the field, and also the free newspapers for the troops. By this means it was very largely possible to deliver papers at headquarters of armies, corps, divisions, and brigades on the day of publication; or in the more distant areas the next morning.

In the reverse direction the transport was used to carry all letters for home from the troops in the field. These mails reached the base port in time to secure despatch to England on the morning after they were posted.

A very large volume of printed matter and stationery issued by the Army Printing and Stationery Services, averaging about 10 tons a day, was distributed by the Army Postal Services.

11. *Dominions and Allied Services.*—Associated with the British Army Postal Services were contingents from the following Dominions and Allied Countries :—

1. Indian.
2. Canadian.
3. Australian.
4. New Zealand.
5. South African.
6. Portuguese.
7. Central American Units.

12. *Postal Contingent for Other Theatres of War.*—Early in 1915, the Mediterranean Expeditionary Force was formed, and several postal officers were sent from France. The postal staffs for the Salonika and Egyptian Forces formed later on were largely provided from the B.E.F. establishment.

In November, 1917, the Italian Expeditionary Force was formed from troops in France.

The field post offices accompanied their respective divisions, and officers and other ranks to provide for the direction and lines of communication services were found mainly from France.

Finally a postal contingent was provided from the B.E.F. for the North Russian Expeditionary Force in August, 1918.

The mails for the Salonika, Egyptian, and Italian Forces were mainly transmitted through France.

13. *German Offensive, Spring,* 1918.—The organisation briefly sketched in the foregoing pages enabled the postal service to meet successfully the calls made upon it throughout the varying phases of trench and offensive warfare. Considerations of space preclude

any description of its operations up to the opening of the great German offensive of March, 1918. The enemy attack of this date in the direction of Amiens and the consequent retirement of the Third and Fifth Armies imposed perhaps the most serious test on the organisation of the Army Postal Service throughout the whole campaign, and it may therefore be of interest to give here a brief statement of the proceedings during that period culled from the official diaries.

Since the withdrawal from Belgium to the Marne in 1914, when the organisation of the Army Postal Service was in an elementary stage, the British Army had not been involved in any movement of a retiring nature, and all preparations for such an event were based on theory rather than practical experience.

It was realised that all the military difficulties inherent in a retirement would have their postal counterpart, and that the task of grappling with the problems of an advance were simple in comparison with the difficulties which would be met with if and when the forward postal lines of communication became suddenly broken or were pressed back on or behind the advanced concentration centres.

At the commencement of the battle nearly all brigade field post offices were transferred from brigade headquarters to the appropriate company of the divisional train in accordance with standing orders. It soon became evident that fighting units would be unable to accept delivery of all their mail, particularly parcels. This was anticipated from the commencement because of the experience gained in previous operations; but the conditions called for different action. During offensive operations divisions could not be cumbered with heavy mails for a day or two, and it had been customary in such circumstances to establish divisional mail dumps in the field and not to interfere with the normal flow of mails from the base to railhead; but to follow such a course during a retirement would have been to court disaster. Accordingly, when it became evident that a particular formation could not accept mails it was arranged to re-consign them to the base, and to stop further consignments from being sent up. These mails were mainly parcel mails, as in many cases it was possible to effect delivery of the letters. By the 29th March some 20,000 bags had thus accumulated, and as divisions were withdrawn from the battle, the mails were sent up to them.

The cross post and express services for headquarters of formations were generally maintained without delay, and the collection and disposal of postings were effected with regularity.

A point of general interest was the great popularity of the field service postcard. The troops generally were too unsettled to write many letters, but they were keen to get field service postcards away.

One division reported that "whenever our lorries passed troops on the road we were assailed with requests for F.S. postcards." Fortunately the post offices were able to distribute their reserve stocks.

On the 21st March the whole area of the Third and Fifth Armies was subjected to a heavy bombardment, and a certain amount of dislocation of services resulted from the sudden suspension of train services, and the destruction of or damage to railhead and other post offices. The distribution mail train running *viâ* Albert to Arras and Doullens stopped at Albert, and did not make the return trip. The outward mails were distributed from Albert by lorry, and formations in the Arras area were linked up by lorry with St. Pol. The Foreste Section truck was stopped at Nesle and was cleared there.

Railhead post offices at Arras, Boisleux, Achiet, Bapaume, and Roisel had to be hurriedly evacuated. Arras was heavily shelled and roads became blocked with débris, making it difficult to get mails to some of the offices. One of the postal lorries got fixed in a shell hole, and a corporal in charge of the postal column was severely wounded and died a few days afterwards.

At Achiet, the post office hut was destroyed, and the divisional postal lorries were destroyed by shell fire. Other lorries were obtained, and the services were maintained. Two sappers were severely wounded, but work was carried on in an adjacent post office, which was also destroyed later after it had been evacuated. At Bapaume work had to be suspended for periods, and one sapper was wounded by shrapnel. The post office hut at Bertincourt was destroyed by a shell, the mails, date stamps, etc., were recovered, but unfortunately a sapper was killed outright. Etricourt, though well forward, escaped, and mails were delivered and despatched in normal course.

Roisel suffered heavily, and the place had to be left in a hurry. Two post office huts were damaged and a sapper gassed. Of the postal lorry drivers, one was killed and two were wounded. The mails and stock were saved, but the fittings and personal kit were abandoned. One divisional railhead post office had to leave mails behind as well as equipment, because one of the lorries had been hit by a shell, but the warrant officer in charge obtained a lorry and returned and recovered the mails. Meanwhile the incoming supply train had been stopped at Tincourt, where the mails were drawn and disposed of. But here also the conditions became serious. The railhead P.O. was struck by a shell, and the whole of the staff except one were wounded. The supply column corporal was also slightly wounded, but he refused medical attention, and took over the duties of the warrant officer, who had been wounded. With his two

pioneers and the surviving member of the staff he carried on the work of the railhead office and the division generally until reinforcements arrived.

Foreste and Flavy le Martel railhead post offices had to be abandoned in face of the enemy advance.

On the 22nd, 23rd, and 24th March the rearward movement continued. The cross-country mail train continued to run as far as possible. Work at the postal depôt at Albert was interfered with by continuous bombing raids, but all despatches were made as usual. During the day all offices at Peronne were withdrawn. Mails and records were brought away, but two offices had to leave all fittings behind. The N.C.O. who had to evacuate his office at Bertincourt the previous day, obtained a lorry during the morning and tried to return to salve the office equipment, fittings and kit, but was forced to abandon the attempt owing to heavy fire. At 3 p.m. he made another attempt with four volunteers and in spite of heavy fire managed to recover everything of value.

The most critical period from a postal point of view had now arrived. The principal Third Army postal depôt at Albert found itself almost in the front line; the Fifth Army depôt at Amiens was working under serious difficulty caused by heavy bombing at night, and the depôt at St. Pol was also disturbed for the same reason. The postal distribution trains ceased running. The postal depôt at Albert found itself unable to carry on owing to continuous bombing and machine-gun fire from aeroplanes; the town had already been evacuated by civilians. A truck with undelivered unit mails was accordingly made up in haste and despatched by the last train to leave. The outgoing and cross post mails were sorted during continuous air raids, and a complete despatch was made by lorry *viâ* Amiens. The office had then to be abandoned, but all records and stocks were successfully removed.

The enemy thrust for Amiens had now developed into a wheel southwards towards Compiègne and Paris, and the southern railheads at Appilly and Noyon were compelled to fall back to Compiègne and Estrée St. Denis. The Third Corps had passed under the command of the Third French Army, and in view of the distance from any postal depôt and the difficulties of telegraphic or other communication, its postal service was subjected to greater vicissitudes than that of any other Corps. The train mails had been held up, but express and inward cross post mails were delivered *viâ* Amiens until the 28th March. Thereafter direct communication was severed and express mails suffered some delay while they were being diverted to the supplies route. It is satisfactory to note that no mails were lost or abandoned, and that outgoing mails were despatched regularly.

By the 28th March the retirement had slackened speed considerably

and had practically ceased except in front of Amiens, where Boves and Longueau railheads were evacuated, and the post offices were moved west of Amiens, and by the 30th the work of disposing of the accumulation of unit mails was well in hand. When this was completed matters may be said to have become normal.

In spite of the rapidity of the enemy advance it is very satisfactory to note that although approximately 250 post offices were involved very little material was lost.

As far as can be ascertained there was only one instance of actual loss of mails. A certain division had dumped their mails for delivery with supplies when orders were given for immediate evacuation of the place. The only lorry available was packed with bags and sent back, the remaining 50 bags being left behind in the care of the military police. These bags were subsequently placed on passing transport under orders of the A.P.M. The bulk was handed back to the post office soon after, but 13 were not returned until 6th April, and three were not recovered.

The enemy offensive which opened on the 9th April on the Armentières-Béthune front led to similar experiences. Railheads of two divisions were very heavily shelled while the loaded mail trucks were in the station. Attempts were made to clear the mails, but only with partial success; some of the postal lorries were destroyed in the process and the railhead had to be evacuated. It was hoped that it would be possible to salve the remainder of the mails when the fire subsided, but although repeated attempts to recover the mails under heavy shell fire were made, recovery proved impossible, and as the enemy forced the line back to the river Lys the same day, it must be presumed that the mails fell into enemy hands, or were destroyed by shell fire. During these operations post offices at such advanced points as Merville, Bailleul, Béthune, St. Venant and Caestre had to be moved back. The large army postal depôts at Lillers and Morbecque had also to be withdrawn, the intervening roads being under continuous shell fire, while the withdrawal in the Ypres salient towards the end of the month, and the interjection of a French Force, necessitated considerable revision of the postal services of that part of the line. After the serious repulse of the Germans on the 29th April the position became more stable. The back areas were continually subject to shell fire, however, and work was carried on at railheads under a certain amount of difficulty. Proven and Poperinghe areas suffered particularly in this respect. The Proven railhead was so heavily shelled that instructions for its evacuation were given. The divisional supervisor and two N.C.O.'s returned however, and cleared the mail track by carrying the bags to the protection of a sandbank under heavy fire. They then fetched a lorry, removed the bags and effected delivery at the normal time.

14. *British Advance*, 1918.—The events of the later months of 1918 created many serious problems for the army postal service. The whole front was in a fluid state and the continuous advance of our victorious troops involved constant re-arrangement of main cross post services and forward movement of army depôts, in some instances to the actual premises they had evacuated a few months earlier, and in others to premises which had been used by the Germans for the same purpose for years. The consequent lengthening of the main services imposed a severe strain on the limited amount of transport available. Further forward in the field the army postal *personnel* had experience in maintaining services for an army advancing against an enemy who was resisting stubbornly and systematically destroying all roads, railways and bridges, either at once or by delayed action fuzes. Under these conditions it was necessary to maintain services in total darkness because of the activities of enemy aircraft. As the advance proceeded the distances between railheads and refilling points increased because the troops outstepped the advance of railheads. The lorry services were then subjected to great strain, *e.g.*, when one corps had reached the line of the Scheldt their railheads were as much as 30 to 35 miles back. In such circumstances it was extremely difficult to avoid delay, not only to mails carried between supply railhead and refilling point, but to the whole of the cross post and express services. Nevertheless the services generally were maintained with but few failures, and there were no instances of serious dislocation.

The corps which advanced from Poperinghe across the stretch of mud and devastation past Passchendaele to Courtrai was in a difficult position as regards road services. When they were beyond reach of the road centre at Poperinghe a light railway service was organised from the terminus of the road service at Poperinghe across to Passchendaele. This was used for mails, and worked satisfactorily until the devastated belt was passed, and a road service could be organised southwards *viâ* Bailleul and Armentières to Roncq, where a distributing centre was established.

Pending a resumption of the French and Belgian civil postal services, arrangements were made to afford postal facilities to the civil population in the area round Lille and in Belgium.

15. *Aeroplane Services*.—Aeroplane services were established in December, 1918, between the base and Cologne and intermediate stations, the longer stages being used for "through" traffic, and the shorter stages for local traffic. In March, 1919, the first overseas service from Folkestone direct to Cologne was instituted.

16. *Travelling Post Offices*.—In December, 1918, a travelling post office was established on the Boulogne-Cologne express, English railway sorting carriages being imported for this purpose.

The advance of the forces into Germany had imposed on the postal services one of the heaviest strains of the war, and in order to keep up the inter-communication and express services the organisation of a chain of lorries from Boulogne to Cologne had hitherto been necessary. The difficulties were increased by the fact that the roads running through the battle area were in very bad condition. The establishment of the railway travelling post office afforded therefore much relief.

17. *Parliamentary Elections.*—The army postal services rendered material assistance in connection with the following Parliamentary Elections :—

Australian Commonwealth Federal Election, April, 1917.
Alberta (Canada) Parliamentary Election, August, 1917.
Saskatchewan (Canada) Parliamentary Election, September, 1917.
Canadian General Election, December, 1917.
Australian Military Service Referendum, December, 1917.
United Kingdom General Election, December, 1918.

In each case special arrangements were made by the Army Postal Services for the delivery of the ballot papers to the troops concerned and for their subsequent collection and delivery to the returning officers.

In connection with the Dominion Elections, the following letters were received by the Director of Army Postal Services :—

(1). *From the Presiding Officer, Canadian Elections in Europe.*

" I have the honour to express my appreciation and thanks for the assistance rendered by you during the past month, when I was charged with the responsibility of supervision and control of the arrangements for the Canadian Elections among the forces in the field.

Had it not been for your co-operation, it would have been impossible for me to complete my work."

(2). *From the Australian Commonwealth Returning Officer.*

" On behalf of the Government of Australia I wish to express my keen appreciation of the excellent postal facilities afforded during the recent Australian Referendum.

The fact that this Australian Referendum occurred during a period when the postal services were rushed with Christmas work makes the exceptional results obtained even more remarkable.

Accept my sincere appreciation."

The United Kingdom General Election, occurring as it did during the Christmas postal pressure and the advance of the British Armies to the Rhine, threw a considerable strain upon the Army Postal Services. The great portion of the election circulars secured delivery to the addresses before the arrival of the ballot papers. Ballot papers correctly addressed were delivered to the military voters within from one to three days after receipt at the base ports in France, according to the disposition of the troops, a large number of whom were then in Germany. An appreciable percentage of the ballot papers were, however, incorrectly addressed and required a second or third handling by the Army Post Office, as they followed men who had moved from formation to formation.

Just as the election pressure began to manifest itself the Army Postal Services were asked at brief notice to undertake delivery to the troops of very large quantities of free newspapers in order that the military voters might have information on which to base their decision when exercising their votes. Over 3,000,000 newspapers were distributed to the troops. The distribution in the back areas was completed the day following the receipt of the newspapers at Boulogne, and in the most advanced areas all newspapers were delivered three days after receipt in the country.

APPENDIX.

ARMIES IN FRANCE AND BELGIUM ONLY, 1916.

Number of Mobile Field Post Offices	412	At the beginning of the War the numbers were 30 and 4 respectively.
Number of Stationary do. ..	111	
Staff of Army Postal Services ..	Officers, 55 Other Ranks, 2970 Men attached for unskilled duties, 500	
Number of bags of mails received from England weekly	Letters, 38,500 Parcels, 84,000	At the beginning of the War the weekly number of bags was approximately 2,000
Number of letters received from England weekly	11,000,000	
Number of letters despatched to England weekly.	9,000,000	
Number of parcels received from England weekly	850,000	During Christmas week 1916 the number was 5,250,000. The parcel traffic began to decline about the middle of 1917 probably owing to food restrictions at home.
Number of "cross post" letters etc., *i.e.*, from one part of the field to another, weekly ..	Official, 1,400,000 Private, 2,800,000	
Postal orders sold weekly ..	81,000 (value £56,000)	
Postal orders cashed weekly ..	46,000 (value £12,600)	
Number of private telegrams delivered by post weekly ..	1,260	

Number of private letter-telegrams despatched weekly ..	1,050
Number of registered letters from England weekly ..	175,000
Number of railway trucks of mails despatched daily from bases	100
Number of motor lorries used daily	240
Highest number of War Savings Certificates sold in one week.	32,726

SOME BOOKS ON THE WAR.

By BRIG.-GENERAL J. E. EDMONDS, C.B., C.M.G., in Charge of Historical Section (Military Branch), Committee of Imperial Defence.

OF books on the War there is literally no end. In the Library of the Imperial War Museum, collected by the care of Professor Oman and its Librarian, Mr. Steveking, there were recently over 13,000; and every week brings more. It would require a well staffed intelligence department to examine them all. Any suggestions as to which are the best to recommend to officers who wish to learn something about the war as a whole must therefore be eclectic. The *Literary Supplement of the Times* is making a speciality of reviewing one or more books on the war each week, and it is worth while spending 2d. on it and cutting these reviews out, for future reference when winter essays and lectures come round again.

First and foremost of English books one must put Major-General Sir F. Maurice's *The First Forty Days*. It is a clear account of the German plans and the opening operations. Against it is its high price, 9s. Then there is Major Becke's *The Royal Regiment of Artillery at Le Cateau* (R.A. Institution, 7s. 6d.), which gives an excellent summary based on official documents of the most discussed of the early fights. As no German account of it has been permitted to appear, it is fair to assume that it was a great British victory. Lord French's *1914* has been exceedingly adversely reviewed by the Hon. J. W. Fortescue, the Historian of the British Army, in the *Observer*. He condemns it "as remarkable for its many omissions as for its obvious contradictions and mis-statements." The Field Marshal was, of course, dependent on his staff for his facts, as Charles II. was on his ministers for his acts; at any rate as a record of personal feelings and impressions of men and things the book is of great interest. The price is, however, a guinea.

The German General Staff have issued an official account of the First Battle of Ypres: *Die Schlacht an der Yser und bei Ypres* (Stalling, Oldenburg, 3s.), which is of extraordinary and absorbing interest, as it gives the German intentions, summaries of orders, orders of battle, etc., so that a complete picture of the immensity of the enemy's effort to reach Calais is presented. Unconsciously it is one of the highest tributes to the bravery and efficiency of the Old British Army, as it credits it with perfect entrenchments, countless

machine guns, deadly accurate artillery fire, and numerical superiority. A translation of the book is shortly to be published by Messrs. Constable and Co.

The advance notices of Sir Julian Corbett's first volume of the official *Naval History of the War* up to and including the battle of the Falklands have appeared in the Press, and it is expected that it will be available in the autumn. I have had the privilege of reading it in proof. Apart from the interest of the subject, and the way it is treated, the book will do more to make army officers understand the *rôle* of the Navy in war than any other yet written; and they will realize how much the Navy did to get the Army and its supplies safely to the places where they were required.

Admiral Lord Jellicoe's book is rather for naval experts and statesmen than for the military reader and its price 31s. 6d. is a consideration.

For the early part of the war one is bound to go to French and Belgian books. Of a large number read, apart from M. Gabriel Hanotaux's many volumed work, *Histoire illustrée de la Guerre*, and General Palat's authoritative book, the fourth volume of which still leaves the war on the left flank of the Allies at 25th August, three books stand out. They are (1) General Berthaut's *L'Erreur 1914* (4.50 francs). This gives an excellent account of the reasons for the opening strategy of the French, the possibilities open to the Germans, and generally the preliminaries and commencement of the campaign. (2). *Le Revers de* 1914 *et ses Causes* by Lieut.-Colonel Thomasson (4.50 francs). This besides giving an account of conditions in the French Army before the war, describes and discusses the operations which led to the French retirement in August 1914. (3). The Belgian official account:—*L'Action de L'Armée Belge: Periode de* 31*st Juillet au* 31*st Décembre*, 1914, published by Chapelot, Paris, price 1s. A clear sober statement of facts. It should be read in conjunction with *La Campagne de L'Armée Belge* (31st Juillet, 1914—1st Janvier, 1915) published by Bloud et Gay, Paris, price 1.50 francs, which adds flesh and blood to the skeleton of the official narrative, and provides a good deal of information about the sieges of Liège, Namur, and Antwerp. There are besides, two excellent little French accounts by Pierre Dauzet, both 2.50 francs, plus 30 per cent., each:—*De Liège à la Marne* and *La Bataille des Flandres*, which narrate the whole of the operations to the end of 1914. They are easy reading and generally accurate.

For the battle of the Marne there is also a good little book in French, price 2 francs, by Gustave Babin, with nine sketch maps, showing the approximate positions of the armies on each day; those of the French, but not the German, are accurate. The best account of the Marne, however, has been written by a Swiss General Staff Officer, Major Bircher, in *Die Schlachten an der Marne* (Berne.

Haupt, 11s. 6d.), which has an excellent map giving the route of von Kluck's corps.

Of German books, besides the official account of Ypres, there is also one on the opening operations in Belgium entitled *Lüttich—Namur* which has a detailed account of the initial deployment, with map, and of the sieges of the two fortresses. Of diaries and personal accounts there is no end, but few are of much value except the novelist Walther Bloem's *Vormarsch*, which presents a vivid picture of von Kluck's army from the time it left Germany until it reached the Aisne; and Hofprediger Vogel's 3,000 *Kilometer mit der Garde Kavalerie*, concerned with the doings of the Guard Cavalry Division from August, 1914, to March, 1915. Both these books are exceedingly well written and instructive.

The only one of Engineer interest yet seen is Biernatski's *Als Pionier in Frankreich*: the letters of a subaltern in a Field Company to his wife. He tells her freely about the bridges he builds, the wire entanglements he puts up and other details which must have been rather boring even to an affectionate German *Frau*.

For the diplomatic and political moves between the murder of the Archduke Franz Ferdinand and the commencement of war, there is Professor Oman's masterly summary entitled *The Outbreak of the War* (H.M. Stationery Office, 2s. 6d.).

The following are recommended for the general reader who is tired for the moment of mere military history:—

Belgium under the German Occupation, by Mr. Whitlock, the American Minister in Belgium (Heinemann, 25s.), a most striking story by a skilled writer; *Scenes from Italy's War*, by Garibaldi's historian, G. M. Trevelyan (Jack, 10s. 6d.); *The Last Million*, by Ian Hay, of the *First Hundred Thousand*, (Hodder and Stoughton, 6s. net), although written principally for an American public it is nearly as interesting as his first military book; and last but not least, *Les Silences du Colonel Bramble* (Paris. Grasset, 3.50 francs), an inimitable appreciation of the British officer by a French interpreter.

Some suggestions as regards books on the campaigns other than in France will be offered in a subsequent notice.

THE RAISING AND REPAIR OF THE RAILWAY BRIDGE AT HOUPLINES.

By MAJOR E. M. SINAUER, R.E.

THIS work was carried out in 1915 by the 8th (Railway) Company, R.E.

General Description of Bridge and Damage done by the Enemy (see *Photo* No. 1).—The bridge carried a single line of railway (Armentières-Comines Line) over the river Lys at Houplines, just east of Armentières. It consisted of a single span, 125 ft. clear, the total weight being about 100 tons. It was blown up by the enemy on 15th October, 1914, being cut between the 4th and 5th panels. Both lower booms and the west top boom were entirely cut through, the east top boom being bent into a " V " at the lowest point. One cross girder, four rail-bearers and many braces were badly damaged. There were also many other holes in various members, repairable by patching. Both shore ends had slipped forward on the abutments, and the two pieces of the bridge were slewed 18 in. down stream.

Description of River at the Site.—The river Lys is canalized at this part of its course, with the tow-path on the left (north) bank. It marks the frontier here, the north bank being Belgian, and the south, French. The general cross-section is as follows :—

North Side :—There is a sharp fall to the deep channel, which has about 13 ft. of water, the bottom being hard.

South Side :—A mud bank projects out into the stream, ending suddenly in a very sharp fall to the channel ; the mud here is very soft and 5 to 6 ft. deep.

The contour of the firm ground under the mud is by no means parallel to that of the surface. The section is further complicated by the fact that, owing to the river making a bend, the deep channel runs diagonally and not along the axis of the river.

During the winter and early spring there is a considerable current, and, owing to the sluices lower down the river being in the possession of the enemy, heavy rains caused rapid floods. These floods considerably hampered the work in its early stages. In the late spring and summer the current is gentle, and the normal water level well maintained.

Military Situation.—The enemy trenches in front of Frelinghien were about 3,000 yards only from the site, and from them both ends of the bridge were plainly visible, though the centre was hidden

from view by some small houses on the north bank. In view of this, the work was at first proceeded with very gingerly. Originally it was not intended to complete the work until the enemy had been pushed back, but only to raise both ends just clear of the water, so as to prepare the steel work for the new pieces. As, however, the enemy did not display overmuch interest in the proceedings, it was later on decided to complete the work.

Owing to the proximity of the enemy no trains could be run to the site. Material sent by rail had to be unloaded at Armentières Annexe Station, 1½ miles away. The bridge itself was only shelled twice during the progress of the work, and no damage was done. Owing to several of our batteries being in position near by, the neighbourhood was frequently shelled, but the casualties amounted only to two men slightly wounded.

General Scheme.—The general scheme for the work was to float out and sink sleeper cribs in the stream, and from these to jack up the two halves of the bridge. The damaged portions were then to be cut away and new pieces fitted in, thus effecting a permanent repair, and also clearing the waterway for navigation. The first lifting had to be done by baulks placed under the top booms, the cribs being on the outside of the girders. When the lower booms were sufficiently clear of the water, four new cribs were introduced under them, and the jacks applied directly under the girders. As the lower booms had been entirely submerged, the damage to these could not be seen until they had been raised clear of the water. When this had been done, the damage turned out to be of a greater extent than had been anticipated, necessitating new pieces of considerable length and weight.

Preliminary Work.—The east top boom was cut with gun cotton, thus leaving the two pieces of the bridge quite free. As many of the rails, sleepers, etc., as could be got at were removed. Dug-out shelters for the working party were prepared on the sheltered side of the railway embankment on both banks.

Anchorages.—Both shore ends were anchored back to prevent any tendency for the girders to slip off the abutments during raising. These anchorages consisted of buried logs, from which led several returns of 2-in. wire rope. Round the end of each girder was a stout chain, and this was connected to the wire rope by railway screw couplings, taken from damaged trucks. These couplings were used to take in the slack as the girders rose.

Design of the Cribs (see *Plan* No. III.).—Careful sections of the river were taken at the exact spots where it was proposed to place the cribs. The bottom of each crib was designed to fit the bed of the river. On the north side, where the bottom was hard, this worked very well, all four cribs settling only a few inches and remaining vertical. On the south side, on account of the depth of soft mud,

great difficulty was experienced. Owing to the slope of the mud, a horizontal solid mud-floor would have caused the cribs to tilt badly. It was therefore decided to try and sink the cribs through the mud like caissons, until the hard underlying bottom was reached.

Of the first two cribs placed here, No. 4 gave no trouble. No. 3 assumed a truly alarming tilt towards the girder as soon as lifting commenced. It was found to be quite impossible to rectify this, except by starting all over again, but as this would have involved lowering the girder again, and even then there would have been no guarantee that the new crib would behave any better, it was decided to take the risk and carry on with it in this condition. The other two cribs on this side, Nos. 5 and 6, behaved fairly well at the start; but when the girders were traversed to their proper axial alignment, they both started to tilt badly. It would appear that these cribs did not get right through the mud to the hard bottom, but, after sinking about 4 ft., attained a position of equilibrium for that particular loading. When the position of the loading was changed even slightly, as when traversing the girders, this equilibrium was disturbed and the cribs started to tilt.

However suitable cribs may be on a hard bottom or on level mud, their use in deep water, on a sloping mud bank, and with heavy loads, cannot be considered satisfactory. The uncertainty as to how they will behave under these conditions, and the impossibility of correcting any tilting, once started, leads to many difficulties and much anxiety.

Construction of the Cribs.—These were all built on the tow-path, to a height corresponding to the depth of water at the proposed position. The sleepers composing them were bored at the ends and threaded on to long bolts. They were ballasted so as to float just clear of the bottom when in position, and were then sunk by extra ballast being put in. The first two constructed had their initial ballast composed of gravel in sandbags, but it was found that, if the crib tilted when being floated out, the ballast shifted, thus upsetting the balance and causing trouble. The remaining cribs were therefore ballasted with short lengths of old rail, spiked on, which proved satisfactory.

Launching and placing the Cribs.—The launching ways consisted of two rails, the shore ends being fastened to the two horizontal rails upon which the crib was built, and the outer ends being spiked to a sleeper, which acted as a distance piece. The centre lines, and the up-stream and down-stream faces were marked on the cribs in white paint before launching. Corresponding marks were placed on the girders to show the exact positions of the cribs. Head ropes and foot ropes were attached for manœuvring the cribs into position. After launching, the crib was towed to its position, and then sunk until it rested on the bottom by putting in extra ballast.

Lifting Baulks.—For the first stage of raising, baulks under the top

boom were used. For the short (north) end of the girder one 10 in. × 20 in. × 30 ft. was employed, and for the long (south) end two 10 in. × 20 in. × 40 ft. bolted together. To assist in keeping the baulk vertical as the girder rose, semi-circular saddles of wood, sheathed with iron plate, were placed on the baulk where it came in contact with the upper boom. To take the heads of the jacks, oak blocks were used.

Jacks.—The jacks available were four 40-ton hydraulic non-traversing, two 30-ton hydraulic traversing, and six 15-ton screw traversing. The hydraulic jacks were by no means new and gave a lot of trouble. The 40-tonners had too small a base and tended to tilt unpleasantly at the slightest opportunity.

The normal procedure was that the hydraulic jacks did the raising, the screw jacks following up closely the whole time. When the hydraulics were up to their full travel, an extra turn was given to the screw jacks to get them tight up, and these latter then carried out the *rôle* usually filled by wood packing. The great advantage of this was that none of the height gained was lost when changing the jacks for a fresh lift, as is always the case with timber packing. As an additional precaution, the lift was also followed up with emergency timber packing.

As speed was no object, safety was a primary consideration, and it was found to be advisable to change the jacks for a new lift on only one crib at a time. Changing them on both sides simultaneously tended to set up movements in the girders and cribs which might have got beyond control. The question of supervision also affected the speed. Owing to the great liability of the 40-ton hydraulics to tilt, and to the unreliability of the cribs themselves, it was considered necessary to have every operation personally supervised by an officer.

As regards the arrangement of the sleepers on the crib to form the jacking floors, although by calculation the sleepers under the load would safely stand over the small clear span, it was found advisable to have several layers solid directly under the jack, as otherwise a considerable portion of the lift was lost through compression and flexion of the sleepers.

Raising.—First Stage (see *Plan* No. I. and *Photo* No. 2).—This went on steadily, the north end first and then the south, until the bottom booms were clear enough for the second series of cribs to be placed into position. As the submerged damaged parts came into view they were examined and the new pieces designed and ordered.

Raising—Second Stage (see *Plan* No. II. and *Photo* No. 3).—The new cribs having been placed under the lower booms, the load was transferred to them, and the lifting baulks removed. The old cribs were partly stripped and left in position as a stand-by, and for construction purposes. For the heads of the jacks a series of oak wedges, cut from old French sleepers, were made. Each set had a smaller

angle than the preceding one, to allow for the flatter slope of the girder as it rose. The upper surfaces were recessed for the rivet heads, which otherwise tended to split the wood.

The two ends were taken up as high as shown on *Plan* No. II. and *Photo* No. 4. At this time, owing to the military situation, it was not proposed to continue any further for the present. The two ends were traversed up stream into alignment. This led to the tilting of cribs 6 and 7 mentioned earlier. The two ends were then left on good packing, and the jacks removed.

Cutting and Stripping.—As soon as the designs for the new pieces were got out, the ends of the old girders were cut and stripped. This went on at the same time as the raising. It had all to be done by hand, no pneumatic plant being available. This cutting and stripping left the last cross girder of the south end unsupported. This was therefore suspended from a baulk placed across the top booms, by two 2-inch wire cables, windlassed taut.

Arrival of the New Pieces.—These arrived in two consignments. The weights of the heaviest pieces were approximately :—

East top boom	...	...	2 tons.
West „ „	...	...	3½ „
East lower boom	...	...	4½ „
West „ „	...	...	4½ „

The first consignment, consisting of the top booms only, were put on two plate-layers' trolleys, and pushed by hand to the site. Trouble was caused by the trolleys being narrow in gauge, and frequently falling between the rails. The second consignment consisting of the remaining pieces, arrived about seven days later. In view of the previous trouble with the trolleys, it was decided to push the large bogie wagon itself round to Houplines by hand. This had to be done at night, owing to most of the line being under hostile observation. All the new pieces were lowered down to the river bank and arranged in order on ways. All the new pieces arrived painted with bright red lead, and were therefore camouflaged with paint to render them less conspicuous.

Size of Rivet Holes.—On the arrival of the new parts it was found that there was a discrepancy in the size of the rivet holes. The new parts had 23 mm. holes for 22 mm. rivets, whereas the holes in the old girder were only 22 mm. This involved reamering out all the holes in the old girders, a very considerable number. This had all to be done by hand.

Final Raising.—It was now decided to risk it and complete the bridge. The final raising was quickly done, and the ends were traversed back on to the abutments so that the gap was four inches longer than the new boom pieces.

Hoisting and Placing New Parts (see *Plan* No. IV. and *Photo*

No. 5).—As the erection of a gantry might have attracted undesirable attention, it was necessary to devise a means of hoisting and placing the new pieces which did not project much above the top of the bridge. The arrangement used is shown on the plan. It was so designed that only materials already available on the spot were required.

The booms were the only pieces presenting any difficulty. The general procedure was that the piece was placed on a small barge floated out under its position, and picked up by the tackle. Whilst being raised it was manœuvred horizontally to clear the girders, and slid into position. The west top boom gave some trouble owing to the joints at one end being interleaved. One end was service bolted, and the gap mentioned before was then closed up by pushing the short end of the girder forward by means of horizontal jacks on the abutment. The other end was then also service bolted. The cutting and stripping, which was all done from the plans before the arrival of the new pieces, turned out to be quite satisfactory, all the new joints being good. A good deal of drilling, all by hand, had to be carried out for the cover plates and bracing. Nearly 3,000 rivets, mostly 22 mm. ($\frac{7}{8}$ in.) were placed, a very large proportion being in awkward places.

As much camber as possible was obtained by forcing up the centre of the bridge by means of the jacks on the cribs, before rivetting. These jacks were left in place until the rivetting was completed. When they were removed the camber was well retained.

Other Work.—After the rivetting had been completed the entire bridge was traversed 6 inches from the south to north, having been unequally on the two abutments.

New rails and sleepers were laid across the bridge. Cribs 1, 2, 3, and 4 were removed; some of the ballast was taken out from them and they were then towed to the bank, pulled out and dismantled. Cribs 5, 6, 7, and 8 were left *in situ*, with some packing under the lower boom, with a view to minimizing the result of possible damage by shell fire (see *Photo* No. 6). Later on they were removed altogether.

In order to strengthen the bridge, which had not been designed for the heaviest type of locomotives, supports were put under the second panel point at each end. These supports were not meant to replace the abutments, but only to take a portion of the load. The old bridge possessed no sway-bracing and some was therefore fitted.

Owing to the military situation, it was not possible to test the work under load.

Time Taken.—The job was commenced on 3rd February, 1915, and completed on 3rd July, 1915. It is to be noted that, owing to the special circumstances, work was not carried on at high pressure. At this early stage of the War, very little railway work was being

THE RAISING AND REPAIR OF THE RAILWAY BRIDGE AT HOUPLINES.

Photo No. 1.

Photo No. 2.

Photo No. 3.

HOUPLINES

THE RAISING AND REPAIR OF THE RAILWAY BRIDGE AT HOUPLINES.

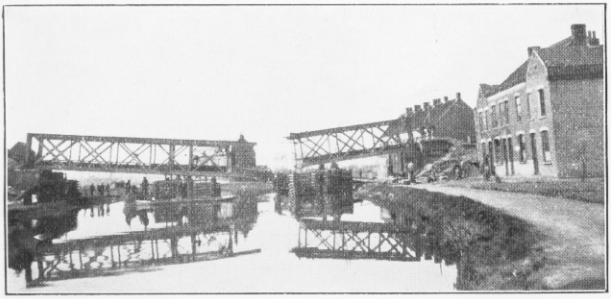


Photo No. 4.

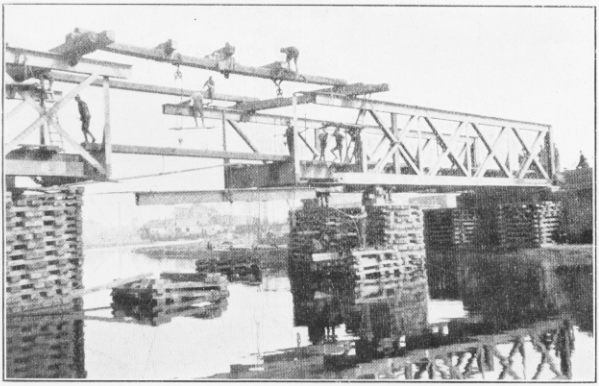


Photo No. 5.

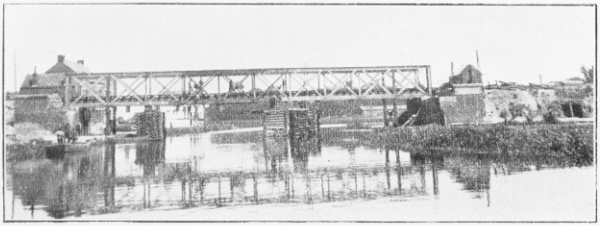


Photo No. 6.

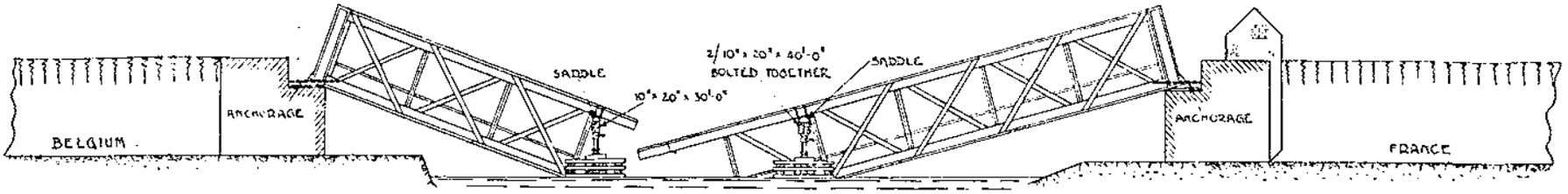
HOUPLINES

RAISING AND REPAIRING

RAILWAY BRIDGE AT HOUPLINES:

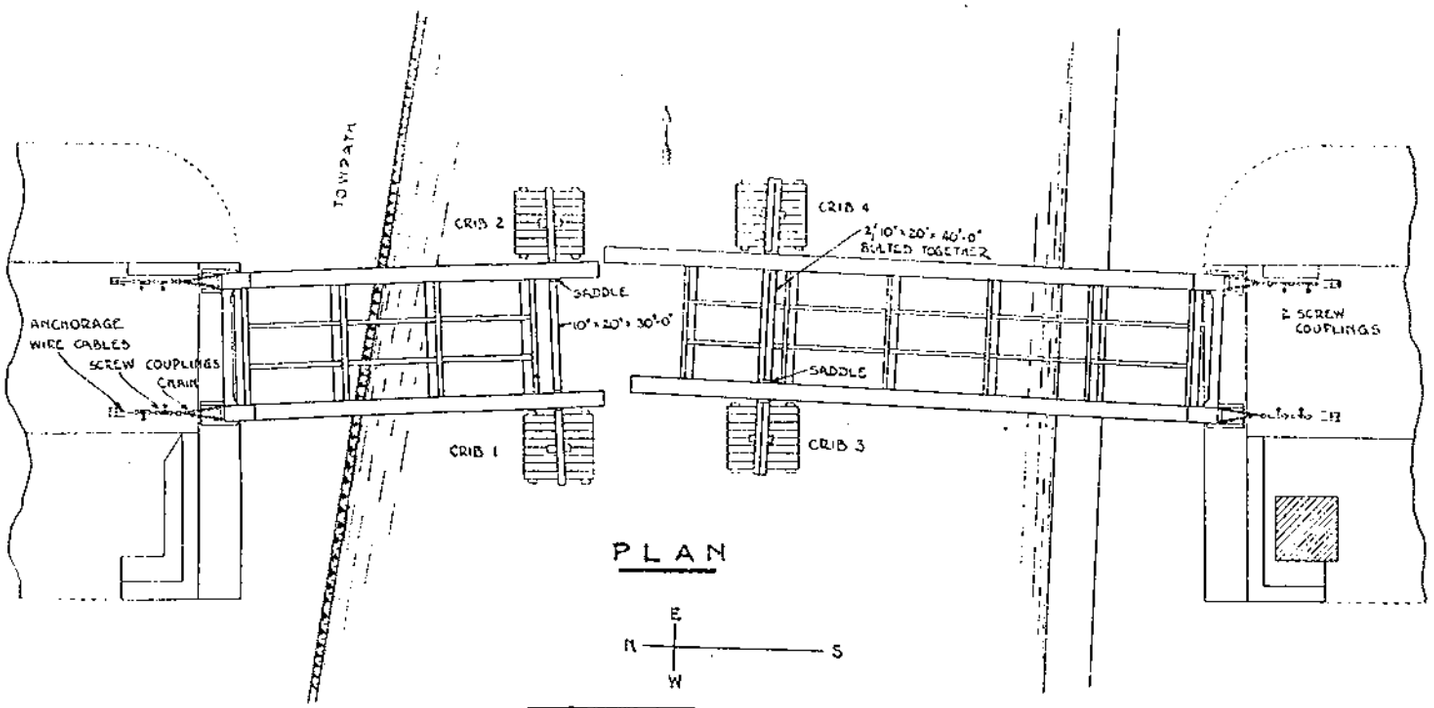
PLAN Nº I.

1st STAGE OF RAISING.



ELEVATION

SKETCH OF BRIDGE AFTER DEMOLITION BY GERMANS



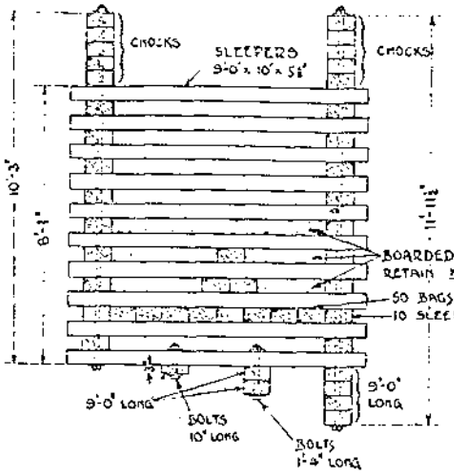
PLAN

RAISING AND REPAIRING

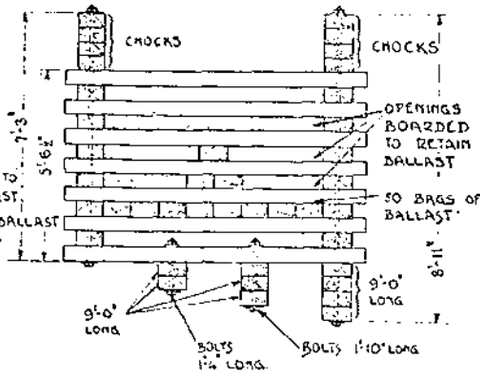
RAILWAY BRIDGE AT HOUPLINES:

PLAN. Nº III.

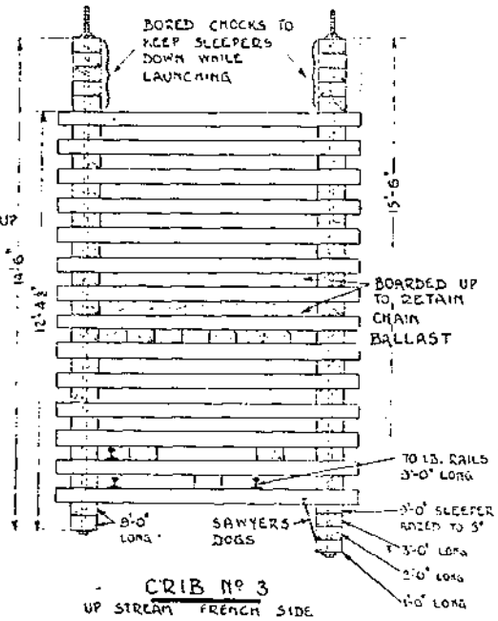
DETAILS OF CRIBS AS LAUNCHED



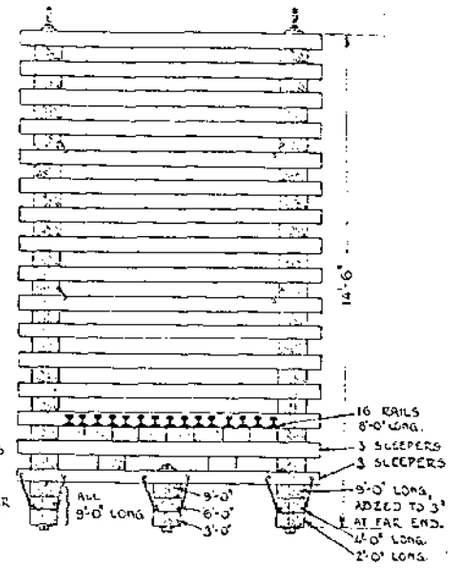
CRIB Nº 1
UP STREAM BELGIAN SIDE



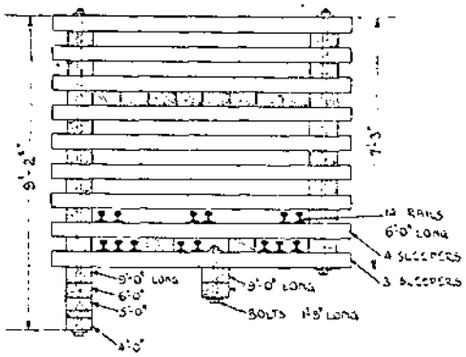
CRIB Nº 2
DOWN STREAM BELGIAN SIDE



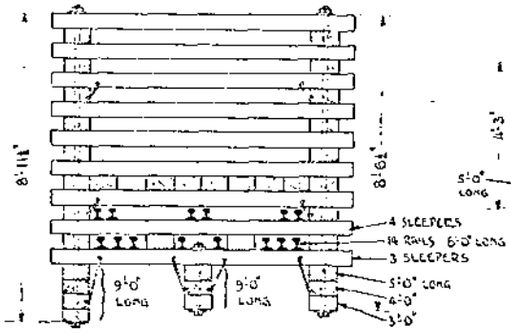
CRIB Nº 3
UP STREAM FRENCH SIDE



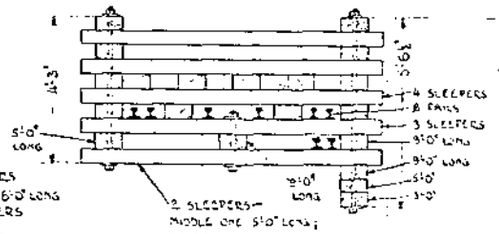
CRIB Nº 4
DOWN STREAM FRENCH SIDE



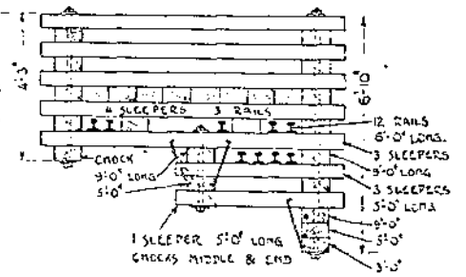
CRIB Nº 5
UP STREAM FRENCH SIDE



CRIB Nº 6
DOWN STREAM FRENCH SIDE

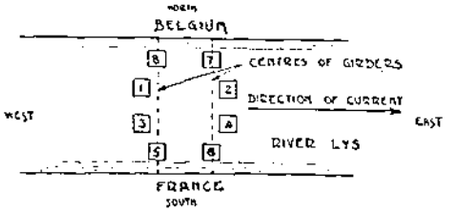


CRIB Nº 7
DOWN STREAM BELGIAN SIDE



CRIB Nº 8
UP STREAM BELGIAN SIDE

ALL BOLTS 1" DIA.



DISPOSITION OF CRIBS IN PLAN.

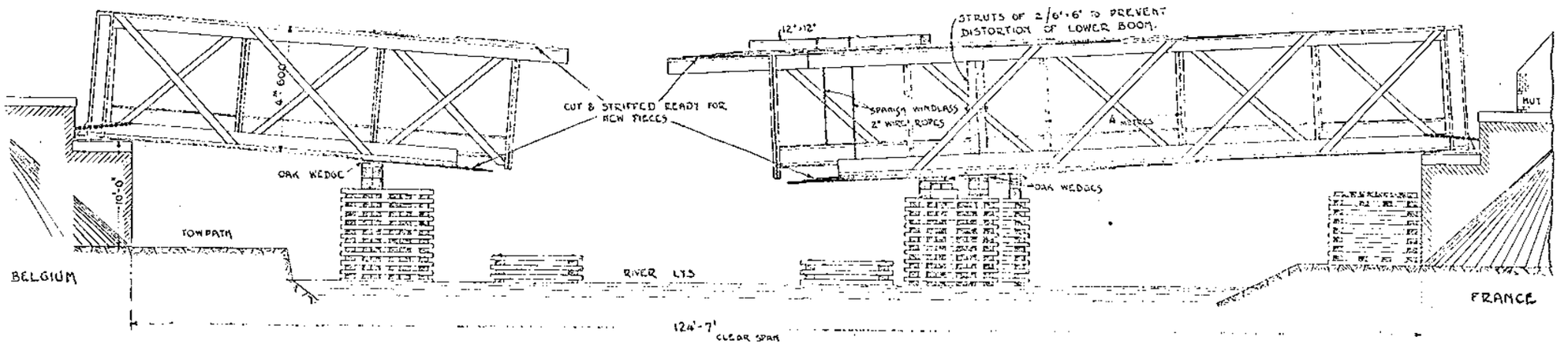
RAISING AND REPAIRING

RAILWAY BRIDGE AT HOUPLINES:

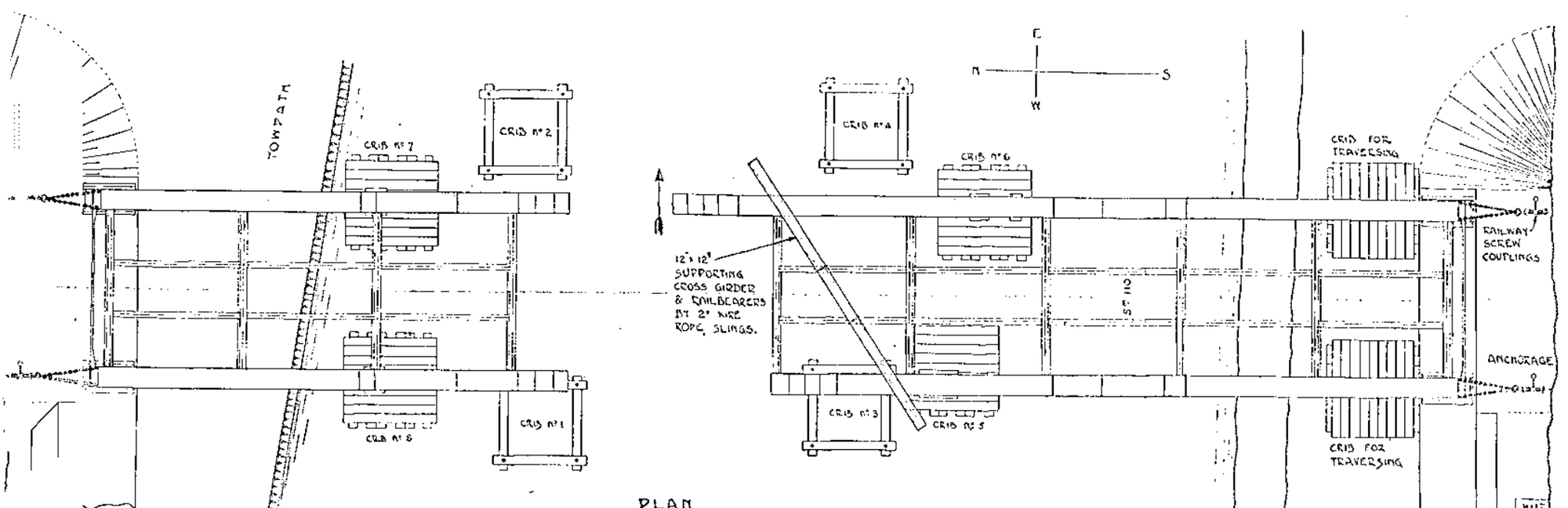
PLAN Nº II.

2ND STAGE OF RAISING.

(JACKS NOT SHEWN.)



ELEVATION



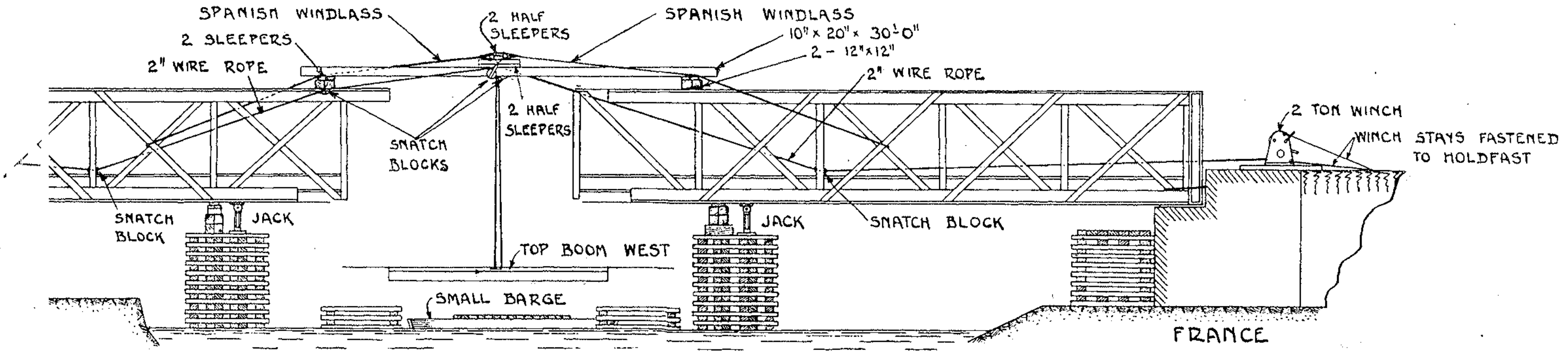
PLAN

RAISING AND REPAIRING

RAILWAY BRIDGE AT HOUPLINES:

HOISTING GEAR FOR NEW BOOM PIECES

PLAN Nº IV.



done by the British Railway Companies, R.E., and the detachment of the 8th Co., R.E., employed on this job, was therefore not required for work elsewhere. It was always understood that, should any advance take place, the work could be hastened and completed quickly. About a month in the middle was spent in marking time, before it was finally decided to carry on and complete the job. Again, towards the end, 16 days were wasted in waiting for the sway-bracing, which was late in delivery. The actual working days were therefore about 90. In view of the special conditions under which the work was carried out, the time taken is no real criterion of how long such a job would take if really pushed, and not so close up to the enemy.

Strength of Party.—The average strength of the party was as follows :—

3rd February, 1915, to 22nd May, 1915...	...	60 men.
23rd May, 1915, to 3rd July, 1915 ...	...	35 men.

All these were sappers, and no unskilled labour was employed in addition. It is doubtful whether a larger party could have been usefully employed, except by working in several shifts ; but in this particular case speed was no object, and in any case flares for night work would not have been permissible.

With regard to officers, for the first month-and-a-half the equivalent of only 1½ officers were available. For the next month two officers were on the job, and for the last three months only one. In a job of this kind, where a great amount of personal supervision is required, at least two officers should be available for the work.

Later History of the Bridge.—The position of the front line in this neighbourhood did not move until April, 1918, and so the repaired bridge was never used. When the Germans then advanced, the bridge was again blown up and only a few tangled bits of steel work are all that now remain.

CORRESPONDENCE.

TRANSPORT FOR R.E. FIELD UNITS.

To the Editor, R.E. JOURNAL.

SIR,

May I be allowed the space to make a comment on Capt. Pennycuick's letter in the June *R.E. Journal*, in which he recommends the use of a "motor-tractor of the tank type" to draw the transport of R.E. field units.

The principle would appear sound enough for trench warfare; but it must be recollected that this is only a temporary phase and that armies cannot afford to give up their mobility. During a rapid advance, as has been proved last year in France, field troops depend almost entirely on pontoon bridges. It is obvious therefore that an R.E. field unit must be able to cross such a bridge.

This surely is the root of the whole matter. Until field companies carry equipment capable of taking motor-tractors of tank type, they cannot be equipped with such a form of transport. The present heavy pontoon bridge, as erected in 2nd Army Area in 1918, would absorb the whole existing equipment of the divisional R.E., not to mention the extra parts, joists, etc., for one gap, and is therefore out of the question. Probably an entirely new design of field bridge would be required before this alteration in transport could be made.

Yours faithfully,

J. B. GLUBB, *Lieut., R.E.*

Col E C Seaman CB CMG RE

MEMOIR.

COLONEL E. C. SEAMAN, C.B., C.M.G.

EDWIN CHARLES SEAMAN was born November 4th, 1867—the third son of the late E. C. Seaman. He was educated at Melcombe Regis School where he distinguished himself in mathematics, and entered Woolwich in 1884—passing out 3rd in the list commissioned February 17th, 1886, after gaining the prize for mathematics.

In 1890 he was appointed Assistant Instructor in Submarine mining at Chatham, especially for Brennan Torpedo duty, at which he remained until 1897, during which period nearly the whole of the R.E. *personnel* officers and men who were initiated into those mysteries passed through his hands. He was an enthusiastic and untiring master of that peculiar weapon and was of the greatest value in developing the improvements that were from time to time introduced, until the abolition of submarine mining and the development of the submarine put an end to its use.

After a tour of service in Malta in command of the 28th Company, where he left his mark as the man who, though at all times up to his eyes in work of one description or another, was always ready to take on any outside and unpopular job, such as Secretary of the then enormous R.A. and R.E. Castile Mess, he returned to Chatham in 1902 as Superintendent of the Brennan Torpedo factory until it was closed in 1903.

Another tour of service followed in Malta, with which Island he had formed ties by his marriage with Miss B. Parnis in 1901. He served there till 1908 as Staff Officer to the Chief Engineer.

In 1908 he was selected for the appointment of Inspector of Electric Lights at the War Office, which he held till 1912. During this period the development of Coast Defence Electric Lighting which had arisen out of the abolition of the Submarine Mine Defence and the consequent demands for increased artillery defences, was at a maximum especially in the colonies. Seaman's clear common sense, and infinite capacity for work, again eased the paths of all those concerned in these matters.

Another tour of duty in Malta succeeded in 1912 as C.R.E. until the beginning of the war, when Seaman assumed the duties of Chief Engineer. The following extracts from a letter from Major-General Sir G. K. Scott-Moncrieff bear witness to the

invaluable work done in Malta and up to the date of his untimely death:—"I had known Seaman personally ever since he joined at Chatham in 1886 and I was Assistant Adjutant at the S.M.E., but I first came into touch with him professionally when he was C.R.E. of one of the districts in Malta, and I was inspecting the works in the Mediterranean early in 1914. There was a big scheme under consideration for re-modelling all the important works in that island, and he visited with me, and explained to me on the spot, the various details of what was proposed, at Burghiza, Leonardo, Ricasoli, and other works at the S.E. end of the island. I was very much impressed with the breadth and soundness of his views, and the thorough grasp he had, not only of the principles of defence, but the constructive details of the work. More than this, he had a most comprehensive knowledge of questions of accommodation. The old works at Vittorioso, Cottonera, and Ricasoli had been constructed in mediæval times and the re-modelling of these to suit modern requirements was a task involving much engineering knowledge and ingenuity. He had it all at his fingers' ends, and I was most favourably impressed with all his proposals and with the careful accuracy with which he had balanced the means at his disposal with the aims in view. I was also much interested to hear from him how, the previous year, he had been in charge of the works necessary for our temporary occupation of Scutari in Albania, and the knowledge he had there acquired of local conditions. It was on account of this experience that I arranged in the autumn of 1915 for him to go to that part of the world again, on reconnaissance. After the outbreak of the war, the Chief Engineer (Colonel Horniblow) was recalled from Malta, and Seaman took over his duties. These were very heavy, involving the construction of many temporary buildings, as well as the completion of fortification schemes. From personal correspondence which I had with the Governor (Lord Methuen) I learnt how admirably he carried out these duties, as I had indeed expected. In the month of October, 1915, it was decided by the Cabinet to send assistance to the Serbians, who were then hard pressed, by making a road through the Montenegrin mountains. This decision really came far too late in the day to be efficacious, but as soon as I heard of it, I cabled to Lord Methuen to detail Seaman to go at once to Medua, reconnoitre the route, and send a report to the officer (Colonel Macdonald, D.S.O.) who had been entrusted with the task, and who would meet Seaman either at Rome, or on the spot. Seaman started at once, and by dint of travelling without any baggage managed to reach Albania and make a reconnaissance. His personal belongings were, I think, following him in a small steamer which was torpedoed by the Austrians. He had the greatest difficulty in getting back, finding his way by circuitous routes and with great hardship. The news he brought was I believe of the greatest value to Colonel

Macdonald. He then returned to Malta, but not long afterwards I recommended his transfer home, to be a liaison officer between the Signal Service in the field, and the War Office. This was due to the desire on the part of the G.S. to have a closer touch between the vitally important needs of the Signal Staff in the field, and the War Office branch dealing with signalling equipment of all sorts, especially in connection with wireless work in aeroplanes. After he took up these new duties there was a very distinct advance. We had established at home an experimental W/T Station at Woolwich, and a W/T air station at Biggin Hill, but there seemed to be a missing link between these and the work in the field, which Seaman with his sound knowledge of the subject, his tact and common sense, was able to supply. Whether he was the actual author of the improvements in wireless telephony between aeroplanes I cannot now say, but it was from him that I learned, at Biggin Hill, of the wonderful progress that had been achieved. Most probably the foundations of this success were well and truly laid by Bagnold and Dumaresq, and their able band of assistants, and it was in continuation of their work that he brought matters to completion. When Dumaresq's lamented sudden death left the electrical branch of the D.F.W.'s department without a head, Seaman had brought the co-operation between the War Office base and the work in the field, to such a successful position that I felt he might well transfer his great ability to the vacant post. He had then to face a great expansion of the work. The demands for new signalling equipment, both on land and in the air, were growing enormously, and it became more and more evident that we must assume new responsibilities for supply. While obtaining all the assistance we could from civil sources, it was clear that these must be supplemented by our own efforts. Factories were established under our own supervision for the construction of telephones, and of wireless sets. No fewer than five of these were in full swing when I left the War Office, and in them a regular supply of field telephones, of wireless transmitters and receivers were made up and dispatched to the theatres of war. In addition, there were numerous demands for electrical apparatus for various places, not connected with signalling, *e.g.* the apparatus for electric power at Basra, and the equipment for electric light, etc. at the Egyptian aerodromes. In addition to this, the inspection of R.E. stores at Woolwich had grown into a gigantic organization, and the demands for anti-aircraft searchlights demanded new experiments and manufacture. The work he did was always characterized by the same thorough grasp of principles, and sound practical common sense. His personal tact and courtesy were as marked as his professional ability, and the smooth working of the great organization, and its marvellous economy is largely due to the individual qualities of the man, as well as to the scientific talent he possessed. Indeed I have often thought that the very success of the

work and the absence of friction must have tended to obscure the enormous difficulties involved. It was with the utmost sorrow I heard that he, like Dumaresq—another admirable officer, had died suddenly. There is no doubt that both men gave their lives as really in the country's service as those who fell at the front, and in both cases we have lost men of the highest character, who sought their reward, not in rank or ribbons, but in the consciousness of duty done and in the devotion of their scientific talents to the great cause for which the nation was at war."

The following is a letter from Field-Marshal Lord Methuen, Governor and Commander-in-Chief, Malta, to the Secretary, War Office, dated Malta, 10th August, 1916:—

Sir,—I have the honour to acknowledge your telegram Number 11371 A.G.4.a. of the 8th August, 1916.

It is with deep regret that I lose the services of Lieut.-Colonel E. C. Seaman, Royal Engineers. Without his help I should not have been able to carry out the work required for the formation of the hospitals, and convalescent camps, which from 370 beds will in a short time expand to 27,000 beds.

Not only has he never made a difficulty, however impossible the nature of the site for a hospital camp might appear, but the work was always complete by the day he named, and at a comparatively small cost.

Few men would have had the courage to face the risks which the water supply presented for so large a number of patients. He gave me confidence from the first, and I cannot name any officer I have ever had under my command to whom I have been more grateful for good work done, quietly, accurately, and always with due regard to economy.

I have the honour to be,

Sir,

Your obedient servant,

(Sd.) METHUEN, *Field-Marshal,*
Governor and Commander-in-Chief, Malta.

Little remains to be said. In May, 1919, Seaman was selected for appointment once more to Malta as Chief Engineer, but a sudden attack of apoplexy, on May 9th, put an end to a life that had been devoted gladly and entirely to the service of the country.

The announcement of a well-earned C.B. in the Birthday Gazette appeared too late indeed for the recipient to enjoy the award, but to the greatest satisfaction of those who were aware of the invaluable services that it recognized. Previously to that Seaman had been awarded the C.M.G. for his services in Malta, and the Serbian order of the White Eagle with swords for his work in assisting the evacuation.

REVIEWS.

REPORT OF THE CHIEF OF ENGINEERS, U.S. ARMY, TO THE SECRETARY OF WAR, 1918.

This report on the duties and operations of the Engineer Department, U.S. Army, for the year ending 30th June, 1918, enables one to form some idea of the expansion of the Corps during their first year of war. The original Corps of regulars consisted of a band, seven regiments and two mounted battalions, officered by 359 Engineer Regular Officers, whose normal duties in peace-time included a large amount of civil engineering work, especially in carrying out improvements to ports and river estuaries.

In this connection, the Chief writes:—"The excellent results which have been obtained since the war began by officers of the Corps of Engineers, in organization, supply and construction, both in the United States and France, must be attributed to the prior training such officers had received, and this training has been rendered possible to a very great extent by the action of Congress in placing under the charge of the Corps of Engineers, the river-and-harbour improvements and certain other civil work of the nation. Through such work opportunity has been given for the development of the Corps of Engineers in taking heavy responsibilities, in the habit of making weighty decisions, in meeting sudden emergencies, in the organization, operation, and care of large bodies of men, and in working with men not familiar with or subject to the discipline and regulations of military life. In addition, these civil works have given to the officers of the Corps of Engineers the practice necessary for any professional man, practice which could not be obtained in their ordinary military duties in times of peace. Experience has shown that the adopted practice of having a young engineer officer on entering the service spend his first two or three years in strictly military work and thereafter have tours of duty alternately in civil construction and in military work, keeps the officer fresh and interested in his work; gives him a well-rounded mental and professional development; and produces an engineer officer fitted for any service the war may demand."

The increments of temporary engineer officers and men required for war service were obtained in the following way:—

(1). *National Guard Engineers.*—These were organizations which were drafted from the various States into the Federal Service, and consisted of 17 Engineer Regiments, one for each of the 17 Divisions of the National Guard, with 605 officers.

(2). *Engineer Officers' Reserve Corps.*—These numbered by the end of the period under report 4,670 officers, who were obtained through the

national engineering societies. An Engineer Enlisted Reserve Corps was also started but the men were subsequently transferred into the National Army.

(3). *Engineer Officers, National Army.*—In the autumn of 1917, as a restriction was placed on the number of out-standing commissions, and it became impossible to commission officers in the Reserve Corps and give them some instruction prior to the time they were actually needed for service, it became customary to commission the required officers for the National Army Engineer units, or in the Engineers, National Army. Up to the end of the fiscal year 4,386 such commissions had been issued.

National Army Engineer Troops.—The Engineer quota of a Division consisted of one Engineer regiment, and an Engineer train (1,695 men in all). The regiments had been previously termed "Pioneer" regiments but were now designated "Sapper," to avoid confusion with the newly-formed Pioneer Infantry regiments. Nineteen such divisional sapper regiments were formed and in addition five sapper battalions, one for each of the five corps Engineer regiments.

Special Engineer Troops.—At the beginning of the year 10 special regiments existed, including one forestry, five railway construction, three railway operating and one railway-shop regiment. The following additional regiments, etc., were organized during the period under review:

Forestry Regiment	1	Camouflage Regiment (only two companies as yet) ..	1
Auxiliary Forestry Battalions	3	General Construction Regiments	2
Railway Construction Regiments	2	Water Supply Regiment ..	1
Railway Operating Regiments	2	Mining Regiment	1
Railway Operating Battalions	14	Quarry Regiment	1
Railway Shop Regiment ..	1	Electrical and Mechanical Regiment	1
Railway Maintenance of Way Battalions	5	Crane Operating Battalion (only two companies as yet)	1
Railway Maintenance of Equipment Battalions ..	2	Surveying and Printing Battalion	1
Railway Transportation Battalions	2	Service Battalions	46
Railway Trades and Storekeepers Battalion	1	Motor Transportation Companies	18
Light Railway Construction Regiment	1	Pontoon Trains	5
Light Railway Operating and Shop Regiment	1	Army Pontoon Park	1
Railway Transportation Corps	1	Inland Watering Battalion ..	1
Supply and Shop Regiments..	2	(four companies)	1
Highway Regiment	1	Searchlight Regiment ..	1
		Gas and Flame Regiment ..	1

It is recorded that the 11th (Railway Construction) and the 12th and 14th (Railway operating) Battalions had already received commendations from the Allies for the parts they had taken in battle.

The Gas Defence Service.—An existing instructional Corps of 86 officers and about 200 men became an Engineer service of the National Army in March, 1918.

The Tank Service was organized as an Engineer service, and by March, 1918, numbers stood at—officers 115 and enlisted men 1,050, when instructions were issued to organize it as a separate service.

Railway Transportation Corps National Army.—In October, 1917, after the arrival in France of some of the Railway units a railway transportation service was formed, and subsequently this organization became independent of other Engineer organizations. Altogether 238 additional officers for headquarters and general offices were commissioned in the Railway Transportation Corps, National Army, but the Engineer Department raised the *personnel* and purchased all their supplies and equipment.

At the end of the financial year the number of Engineer officers of all categories was 7,963, and the enlisted strength stood at 214,274, of whom approximately 130,000 had already embarked for foreign service.

The Training of Officers.—It was originally intended that all Engineer officers should receive instruction at Engineer Officers' Training Camps, of which three had been established in June, 1917, and at which the courses seem to have lasted about 10 or 12 weeks, but owing to the speeding up of the Army programme and to a considerable extent to the restrictions placed during the fiscal year on the issuance of reserve commissions, many officers were assigned to active service without any preliminary military training and several hundreds more with very little. In designing the courses of instruction at these camps no attempt was made to teach civil or other branches of engineering as such, as all officers had to be trained and qualified engineers before they could be commissioned. The first requisite in the training of modern armies is thoroughness and precision in fundamentals and details. The courses were designed to teach, as thoroughly as possible, the duties of an officer in the character of (*a*) Instructor, (*b*) Manager, and (*c*) Leader, and included (1) the fundamental training of an Infantry soldier, (2) practical experience in command, including the duties of corporal, serjeant, lieutenant and captain, (3) company administration, supply, and army paperwork generally, (4) applications of the principles of civil engineering to military conditions, especially practical instruction in reconnaissance, bridge-work, trench lay-out and construction, demolitions, etc., and (5) tactics, battle exercises, map problems, terrain exercises and problems in troop leading.

Enlisted Personnel. In the first rush of voluntary recruiting many suitable men were lost to the Engineers, and considerable difficulty was experienced later in obtaining the transfer of these men, who had already proved their value in other units. The sudden expansion of the establishment precluded much central control on the training, and commanding officers, who were at first all regulars, were left largely to themselves. But subsequent inspections showed that methods and results, although excellent as a rule, showed considerable lack of uniformity, and a more centralized control over such training was instituted by the Chief of Engineers. At the end of the period under review methods were being standardized and the raising of Engineer units was being concentrated in a few well-fitted localities. It was expected that by the draft and by voluntary enlistments a sufficient number of skilled mechanics would be obtained, but this was found not to be the case, and before

the end of the period, schools had been arranged for the specialist training of about 1,000 selected men in 19 different trades, including railway operation and construction, pontooning, surveying, sound and flash ranging, mining, electrical work and oxy-acetaline welding.

The Chief of Engineers gives some interesting comments on the lessons of the war as applied to coast defence. Nothing has happened to throw any doubt on the truth of the principle that properly constructed sea-coast defences, properly manned and operated should successfully resist a naval attack. Mobile guns may be introduced, but fixed guns will yet remain necessary. Overhead cover must be strengthened to guard against plunging shots and air-craft bombing. The proposal that it would be better and more economical to emplace sea-coast guns in a much more simple way then has been the custom is not recommended. Of the total costs connected with sea-coast guns the *personnel* items are by far the largest. The additional amounts which must be expended in providing rapid ammunition service and in protection of the gun and *personnel*, must more than pay for themselves in the increased rapidity and accuracy of fire, in the increased protection of the gun carriages and *personnel*, and in a permissible reduction in the strength of the gun detachment.

F.E.G.S.

THE YEAR BOOK OF WIRELESS TELEGRAPHY AND TELEPHONY, 1919.

The Year Book of Wireless Telegraphy and Telephony for 1919 (pub. by "The Wireless Press, Ltd.") has recently made its appearance; it is the seventh annual number of this well-known publication, and like some of its recent predecessors the volume has had to be compiled under the hampering conditions of war and the restrictions imposed by the Censorship. Although these circumstances have prevented certain information on wireless matters becoming available to the public, nevertheless the volume well holds its own as the Guide Book on Wireless Telegraphy and Telephony.

The section devoted to Calendars has been amplified by the inclusion therein of a list of official holidays in various countries; this information will be found extremely useful to business men having commercial relations overseas.

"The Record of the Development of Wireless Telegraphy and Telephony" has been brought down to date. The year 1918 has been marked by no revolutionary changes in radio-telegraphy: the year's developments, however, show substantial steady progress. This progress is briefly reviewed under three main heads: (1) Improvements in Apparatus, (2) Extension of the Application of Radiography, and (3) Long Distance Communication.

It is pointed out under the first of the heads that the trend of progress towards continuous wave communication, as distinct from that by damped waves, has been specially marked. A particular impetus has been given to continuous wave communication by the continued development of the thermionic valve as an efficient receiver and generator of undamped oscillations. It is in the field of receiving wireless signals that the most remarkable progress has been revealed, a progress due almost entirely to the degree of perfection reached in the design and manufacture of thermionic valves. At the same time wireless telephony has progressed very considerably, particularly in the direction of reliability and increase of range; thanks also to the development of valve oscillations and receivers.

As regards the second of the above main heads, the extension of the application of radio-telegraphy has taken place chiefly in connection with the fitting up of installations on merchant ships; at the close of 1918 the number of vessels belonging to the British Mercantile Marine carrying wireless equipment had risen to between 2,500 and 3,000. One of the interesting events of the year was the opening of the powerful station at Balboa, at the Pacific entrance to the Panama Canal. The Chinese Government has also begun to concern itself actively with wireless telegraphy; during last year it let contracts to the Marconi Company for the supply of wireless telegraph and telephone sets and at the same time

concluded a contract with the German Telefunken Co. for the construction of radio-telegraphic stations throughout the Republic.

Dealing with the third of the main heads attention is called to the fact that 1918 will go down in history as the first year to witness wireless communication over the greatest possible distance on this earth—from Europe to the Antipodes. On September 22nd two messages were transmitted from Carnarvon to Sydney, a distance of 12,000 miles. Earlier in the year—in March—wireless communication was established between San Diego, California and Pekin, a distance roughly of 7,500 miles. Several new high-power stations were opened during the year in the U.S.A.; one of them, i.e., that at Annapolis, Md., having, it is said, a range of at least 4,000 miles. The high-power stations at Croix d' Hins, near Bordeaux, and at Stavanger were also opened for traffic, whilst work was in progress, at the end of 1918, on important high-power stations at Buenos Ayres and Karlsborg, Sweden.

A certain amount of new matter appears in the section headed "National and International Wireless Laws and Regulations"; *inter alia*, geographical information relating to the Republics of Ecuador and of Honduras is given for the first time and the wireless telegraph situation in these countries is described; geographical information relating to Iceland, Malta, Mauritius and the Philippine Islands and the laws and regulations in relation to wireless telegraphy in force in these islands being similarly included.

The lists of Land and Ship Stations given in the section "Wireless Telegraph Stations of the World" occupy 250 pages. It has not been found possible, owing to the restrictions placed upon the publishers under the Defence of the Realm Act, to correct or bring these lists up to date. Some alterations, however, have been made in the information given last year. It is noticed that the ranges of a few of the stations have been increased; a few new stations have also been included in these lists.

A "Special Articles' Section" has been a feature of the *Year Book* since its birth; and the contributions from eminent men of science contained in the current issue are quite equal in interest and value to those which have appeared in previous numbers of this publication.

The first of the articles is entitled "Maxwell's Electro-magnetic Theory of Light," and is from the pen of Professor J. A. Fleming, F.R.S. The author reminds us that Maxwell's Electro-magnetic Theory of Light stands as one of the chief landmarks in the history of scientific thought. A brief survey is made of the work on the subject of light carried out by those who preceded Clerk Maxwell and the results of their discoveries are shortly stated. These results provided various arguments for and against the corpuscular and the undulatory theories of light. The true authorship of the undulatory theory of light, it is pointed out, must be ascribed to Robert Hooke, one of the founders of the Royal Society, and at one time its Secretary. Sir Isaac Newton was led to reject this theory, on the ground that an undulatory motion would spread round opaque objects just as sound waves do, and, therefore, that sharp shadows could not be formed. However, such *diffraction* does occur, but the amount of it depends upon the ratio of the length of the wave or undula-

tion to the size of the object—this ratio is, generally speaking, very small. The extreme smallness of the light waves, viz., about $\frac{1}{50,000}$ of an inch, was not apprehended in Newton's time. Newton was also influenced by the phenomenon of the " polarization " of light, then recently discovered.

Further, the enunciators of the undulatory theory assumed that the vibrations of the æther must necessarily be longitudinal and hence there could be no asymmetry in the ray. These objections were subsequently met and overcome, when the tentative speculations of Hooke and his successors as regards the undulatory hypothesis of light were replaced by a scientific hypothesis resting on facts, as soon as the discoveries of Thomas Young and Augustin Fresnel came to the aid of research workers.

From their discovery of the phenomenon of *interference*, in connection with two streams of light proceeding from the same source but by two paths of different length, Fresnel and Young formulated the proposition that light vibrations were transverse or at right angles to the ray. This type of theory had, in the first quarter of the nineteenth century, been found to give a fairly good explanation of the facts of optics, although it created special difficulties of its own which led to the development of numerous æther theories.

Maxwell held that it was unphilosophical to fill space several times over with different hypothetical æthers in order to meet the theories of physicists in relation to electric, magnetic and light phenomena. He therefore presented to himself the problem of deducting from one æther both the optical and electro-magnetic phenomena. Moreover, he was convinced that all speculations as to the inner structure of the æther were likely to be very wide of the truth, and that even if we imagine a mechanism by which we can explain the facts of nature, it does not in the least follow that they are produced in that particular way.

Professor Fleming explains how Maxwell was led from the actual facts of experience based on Faraday's discovery of the creation of an induced E.M.F. in a loop of copper wire when a permanent magnet was moved towards it, to perceive that the same kind of action must take place when a magnet is brought up towards a circuit formed of an insulator, in place of a conductor, only that owing to the insulating quality, the E.M.F. induced could not produce an electric current, but only an electric strain or displacement.

Maxwell also stated a second important principle, viz.: that electrical displacement in an insulator or dielectric, *whilst it is changing*, is in effect an electric current, and must therefore produce around it magnetic force.

Maxwell gave mathematical expression to these two principles. The equations giving the relations of the forces and strains, magnetic and electric, and those formulating the two circuital laws are given by Professor Fleming in the original article, as also the well-known mathematical expressions $-mk\ddot{B}=Curl\ (Curl\ B)$, or $-mk\ddot{D}=Curl\ (Curl\ D)$, which are developed from them and represent a wave propagated in an incompressible material with a velocity $\frac{1}{\sqrt{mk}}$.

In plain language these expressions mean that if an electric current is created in a wire the result is to form round the wire a magnetic force which theoretically extends out to infinity. If the current is supposed to be instantly reversed in direction the magnetic field would not be instantly reversed at all distances, but the reversal would take place at gradually increasing times at gradually increasing distances. That is to say, Maxwell's equations showed that magnetic flux or induction and electric strain or displacement are propagated through space with a velocity of $\frac{1}{\sqrt{mk}}$.

The value of the velocity $\frac{1}{\sqrt{mk}}$ has been found by an experiment, many times performed, to be nearly 300,000 kilometres per second: this is exactly the velocity of light. Consequently Maxwell's investigations led at once to the conclusion that electric and magnetic effects are propagated through space with the velocity of light.

"It was then impossible," Professor Fleming points out, "to avoid the conclusion that the optical and electro-magnetic æthers were one and the same. Also it seemed highly probable that what we call light, is merely an electro-magnetic wave, and that the transverse displacements which constitute that wave are electric and magnetic fluxes or strains."

It will be seen then that Maxwell's theory embraced in one single explanation all optical and electro-magnetic phenomena, and enabled a common origin to be ascribed to both. At the same time it opened up new fields for experimental investigation in which, as is pointed out in the original article, a rich harvest has already been reaped and gathered in.

The second article has been contributed by Dr. W. H. Eccles: it is entitled "Maps for Radiotelegraphy and Aeronautics." It is pointed out therein, that when electric waves from a high-power sending station pass over the surface of the globe, that portion of the energy which reaches a particular receiving station and operates the receiving apparatus, so far as we know, must have travelled from one point to the other along the shortest path; *i.e.*, along the great circle on which both these points are situated. It is sometimes of importance, and often of interest, to trace the path of the electric rays. This can readily be done on a terrestrial globe, but such globes are not always available.

Dr. Eccles points out that given suitable books of tables and the necessary leisure the great circle path can be calculated between any two points and marked on any kind of a map. However, a more convenient method of meeting the situation is that furnished by the plotting of special maps capable of showing great circles' courses as straight lines. Such maps, known as gnomonic projections, not being procurable in a form suitable for wireless students, Dr. Eccles describes, with the aid of diagrams, a simple method of constructing these maps and the scales to be used with them. A gnomonic map with Greenwich as origin accompanies the text of the original article.

The third article is entitled "The Methods and Progress of Radiotelephony"; its author is Mr. P. R. Coursey, B.Sc. The essential

outline of all practical radio-telephone systems may, Mr. Coursey points out, be said to comprise the following parts :—

1. An oscillation generator or source of continuous or nearly continuous waves, for the transmitter.

2. A transmitting microphone, or means of modulating the transmitted energy.

3. A receiving apparatus.

4. An aerial and earth (a counterpoise) system for transmission and reception.

5. Means for relaying to and from existing land telephone lines.

Each of these chief features are dealt with in the original article.

1. *The Transmitter.* The essential qualification is that the transmitter shall be capable of producing a steady train of oscillations of frequency above the acoustic limit (*i.e.*, above, say, 30,000 cycles per second), and preferably still higher, so as to be suitable for efficient operation with aerials of ordinary dimensions. It is not essential that the waves should be continuous, so long as the frequencies of irregularities are above the limits of acoustic frequency range. To render the spark frequency inaudible it must exceed 20,000 per second ; this frequency has been attainable since the invention of the quenched spark gaps. The quenched spark gaps may be operated with either alternating current or direct current, and Mr. Coursey deals, in the original article, with the requirements in each of these cases.

It is pointed out that it is of course possible in the cases where alternating current is employed to use more than three phases, and so have a lower initial A.C. frequency, but for most purposes a three-phase supply best meets working conditions.

With a direct current supply, the sparking rate is determined solely by the constants of the supply circuits charging the main condensers and by the properties of the sparking gap itself. The sparking rate can, therefore, readily be given quite high values and it is possible thus to generate an almost continuous wave eminently suited for telephonic transmissions. In this connection mention is made by Mr. Coursey of the spark gaps of Chaffee, Yagi, Washington and Ditcham, which have been developed for comparatively small power out-puts—using D.C. supply voltage of 500 volts.

Attention is also called to the Marconi multi-disc discharger, by means of which a practically continuous wave can be set up ; the actual instant of sparking being controlled by means of an auxiliary trigger-device. This apparatus is specially suited for use with fairly high-power units.

Until quite recently the best known generator of continuous waves, such as are necessary for radio-telephony, has been the arc—the Poulsen and its modifications. The Colin-Jeance arc in acetylene and hydrogen, the Moretti arc in water vapour, the Dubilier and the Dwyer arcs in alcohol have given more or less successful results in practical telephone working. Ranges of several hundred miles have been obtained by their use.

Undoubtedly the most interesting generators of continuous waves for telephone work are the various forms of vacuum valves. One of the most striking developments in modern wireless work has been that of

the three-electrode valve with its various modern forms, from the small receiving valves to the large high voltage transmitting valves.

The very valuable feature of valves is, as stated by Mr. Coursey, their simplicity in operation and the very great ease of control over the output. They are also extremely useful for simple amplifying work, both at the transmitter and the receiver, and in amplifying the modulations obtained from the transmitting microphones.

Attention is also called to the high-frequency alternators, which provide a means for generating continuous waves; the most notable examples of these alternators are the Alexanderson and the Goldschmidt machines.

2. *The Modulator.* Next to an efficient generator the modulator, or transmitting microphonic apparatus, is the most important part of an installation.

The problem of the transmitter is a very difficult one and is briefly discussed by Mr. Coursey, who mentions the chief methods being employed to provide a solution. Firstly, for low-power work the simplest arrangement is to use a variable-resistance type of microphone either directly in series with or coupled to the transmitting aerial circuit. The attempts to increase the power capacity of the variable-resistance type microphones led to the development of the various forms of liquid microphones—the most successful of these being Vanni's and Chambers'.

Secondly, a means may be employed for modulating the out-going wave by causing the voice to control the timing of the aerial circuit relative to the primary circuit, or to the frequency of the oscillation generator. The earlier forms of "condenser microphones" belong to this class, but have little practical value.

Alexanderson has introduced an improvement recently, namely, the "Magnetic Microphone," designed by him. In this case it is the inductance which is varied by the voice, and not the capacity of the instrument.

Vacuum valves and valve amplifiers constitute a third important class of modulators.

3. *Receiving Apparatus.* Most of the usual wireless telegraph receivers are available without alteration for wireless telephone work and this subject does not call for any special consideration.

The use of receiving amplifiers is an important adjunct for radio-telephone work, and for this purpose valve amplifiers are stated to be the most useful instrument.

The one great difficulty that arises when receiving amplification is resorted to is that of interference, principally owing to atmospherics.

4. *Aerial and Earth Systems.* The requirements for radio-telephony are precisely similar to those of radio-telegraphy and need much the same equipment as that customarily adopted for wireless telegraph stations.

5. *Relaying to and from Land Lines.* It will readily be evident that an extremely important feature of radio-telephony is the need of some form of repeater or relay to link the wireless apparatus to the land line telephone system.

Microphonic types of repeaters—such, for example, as Brown's tele-

phone relays—and valve repeaters are available for this purpose: the latter being the simpler in use as they require less adjustment and attention than the former. Valve repeaters employed in this way may also serve the purpose of amplification as well—a matter which is most important where the received signals are weak.

The great problem still requiring satisfactory solution is that of duplex speech through these repeaters. The actual repeating process is comparatively simple: the difficulty lies in adapting it to comply with the conditions of both the wire and wireless telephone simultaneously.

The various fields of utility of radio-telephony are touched upon briefly in the original article, and it is stated that in America some extensive pioneer work has been already carried out by one or two railroad companies in connection with the application of radio-telephony to railway train communication.

The interesting announcement is made that "The range over which speech has been heard has already reached some 5,000 miles." This result was achieved with a large number of valve transmitters in parallel—a method which is at present too costly for such long range work on a commercial scale. The hope is expressed by Mr. Coursey that the return of peace conditions will allow research work to be again taken in hand and that the solution of the problems which are still outstanding will be the result.

The fourth article is entitled "On the Determination of the Electrical and Acoustic Characteristics of Telephone Receivers." Mr. Louis V. King, D.Sc., F.R.S.C., its author, points out that, since its invention in 1877, the telephone receiver as originally developed by Alexander Graham Bell has come into general use. With increasing ranges of transmission in telephony and radio-telephony in recent years more attention has been directed to the telephone receiver itself as a vital part of the receiving apparatus in its essential function as a detector of extremely small variations of electrical energy. The main features of the instrument in its present form are briefly discussed by Mr. King with a view to directing attention to points in the design of the receiver which require further investigation. The subject is treated mathematically under the headings: "Elementary Theory of the Telephone Receiver"; "Measurement of the Electrical Characteristics of Telephone Receivers"; "Note on the Precision Measurement of Frequency"; "Measurement of the Audibility Characteristics of Telephone Receivers"; and "On the Acoustic Out-put and Efficiency of Telephone Receivers." The original article is provided with a number of diagrams, and is of a nature which does not lend itself to reproduction in abstract form.

The conclusion arrived at by Mr. King is that the telephone receiver considered as a means for transforming electrical energy into acoustic out-put is an extremely inefficient instrument; the magnetic hysteresis losses being chiefly responsible for this.

The recent trend of radio-telegraphy in the matter of power economy and long-distance transmission has led to a demand for increased sensitiveness in the receiving apparatus. The introduction of current amplifiers of various types, giving magnifications reaching to a hundred-fold and more, has to some extent met these demands. However, the

essential requirements of to-day can alone be satisfactorily met by marked improvements in the design and construction of telephone receivers leading to higher acoustic efficiencies. Mr. King has directed attention to some of the more important directions in which alterations are required in existing forms of telephone receivers and he urges that the subject should be further investigated.

The original article concludes with a useful list of works dealing with the subject.

The last article is contributed by Dr. N. W. McLachlan, D.Sc., Eng., and deals with "Some Radio-frequency Phenomena." In this article are discussed some of the phenomena which the electrical engineer meets with when dealing with alternating currents. Dr. McLachlan points out that in the transmission of power by low-frequency alternating currents of 50 periods per second, two sets of phenomena are present: (1) Transient phenomena—*e.g.*, the phenomena accompanying the sudden switching in of a transformer or a long transmission line; in such cases electrical oscillations similar to those met with in the oscillatory circuits employed in radio-telegraphy are set up. (2) The phenomena which occur when an alternating current of fixed root mean square value flows through the circuit.

When low-frequency currents were first used commercially, it was found that cables constructed for the transmission of direct currents were unsuitable for alternating current. This was due to the fact that the same wire offers greater resistance to the passage of an alternating current than to that of a direct current, owing to (*a*) increased resistance caused by skin effect, and (*b*) increased reactance, which depends on the product of frequency and inductance. The situation was met by the construction of cables in which the conductors consisted of a number of small-diameter strands, each of which was insulated and properly spaced.

Again, in the case of a wire carrying an alternating current of constant root mean square value, assumed to be sinusoidal in wave form, the voltage drop across its ends depends upon (1) the frequency of the current, and (2) the configuration of the circuit. There is another effect which becomes prominent at high frequencies, viz., the self-capacity of the wire: this depends on the configuration of the wire, and is greater for a loop than for a straight wire. It is the capacity current and not the actual value of the capacity which increases with the frequency. The capacity current I is obtained from the formula $I=\omega KE$, where $\omega=2\pi f$, K=capacity and E=voltage.

There are, Dr. McLachlan points out, two additional effects which are of importance at high frequencies when the length of the wire is great, as in transmission lines, viz.:—(*a*) mutual inductance between the wire and earthed bodies; and (*b*) capacity between the wire and earthed bodies. These effects are due respectively to the magnetic field caused by the current and to the fact that there is a difference of potential between the wire and earth. Mutual inductance reduces the inductive effect of the current, whilst capacity to earth increases the capacity current.

The effects of high frequency oscillations in coils and in condensers

are described by Dr. McLachlan, and he points out that in the case of coils, radio-frequency effects are modified if the core is iron or even a non-magnetic conducting material. The effect of inserting an iron core in a coil carrying a high-frequency current (assumed constant in magnitude and wave-form with and without the iron) is to increase the voltage in the terminals, and, therefore, the voltage between consecutive turns. This causes an increase in the self-capacity current of the coil, the earth capacity current, and in the dielectric loss in the insulation on the wires. Further, the power factor of the coil is increased due to both the iron loss and the dielectric loss. Thus, what may be termed the equivalent resistance of the coil is increased.

Attention is called in the original article to the uses to which the ionic valve is being put: in conjunction with oscillatory circuits, it has proved to be an excellent means for obtaining a high frequency, undamped and almost sinusoidal current; it has been of service in experimental work and in radio-transmission from aircraft, where small power is needed; it has also been used as a detector and amplifier in wireless and in other work.

Dr. McLachlan, in conclusion, briefly outlines a medical application of radio-frequency currents. Direct currents or low-frequency currents, it is well known, cause violent contraction of the muscles and considerable pain when passed through the human body. On the other hand, high-frequency currents of the order of a million periods per second, are used, no sensation other than that of heat is caused, even when the current density is large. Such high-frequency currents are used in the treatment of certain diseases and is termed diathermy. The temperature of the body can be raised several degrees above its normal value of 98·4° F. by such currents. The heating of the tissues is probably due chiefly to dielectric hysteresis, although part may be due to conductivity.

Some important and valuable notes are contributed by Mr. I. Shoenberg on "Value Patents for 1918." These notes are followed by "Particulars of Wireless Telegraph Patents in 1918." In the introductory paragraphs relating to the latter subject, it is stated that the records of the Patent Office show the number of applications filed during 1918 to be 21,932, an increase upon those of the previous year of over 2,000 applications. The number of applications relating either directly or indirectly to "wireless," however, shows a small decrease, the total being but 148, as compared with 160 in 1917; of the "wireless" applications by far the most important place is occupied by "valve" inventions.

In the section devoted to "International Time and Weather Signals," a *résumé* is given of the world-wide programmes relating to "Time Signals." A brief account also appears under the heading "Meteorological Signals," of the part meteorologists have played during the war in connection with aviation, etc.

The volume concludes with the "Useful Data Section"; but it has been found impossible to continue the development and expansion of this section *within the covers of the Year Book*; in consequence, a separate volume entitled *Standard Tables and Equations in Radio-Telegraphy*, to some extent a supplement to the *Year Book*, has been published.

The following information, *inter alia*, still appears in the *Year Book* :— Definitions of terms used in Wireless ; Dictionary of Technical Terms ; International Rules for the Use of Symbols representing Quantities in Mathematical Calculations ; Weights and Measures (British and Foreign) Specification of the Beaufort Scale ; foreign and colonial money ; particulars of the leading companies engaged in the commercial development of wireless telegraphy ; biographical notices of those prominently associated with wireless telegraphy ; literature of wireless telegraphy and telephony ; directory of Wireless Societies ; and Lloyd's List of Signal Stations.

The *Year Book* certainly deserves a place on the book-shelves of every reference library, public or private.

W. A. J. O'MEARA.

NOTICES OF MAGAZINES.

THE MILITÄR-WOCHENBLATT.

The Militär-Wochenblatt is still appearing thrice weekly in the old style, with the gazette and everything else, except the long list of decorations bestowed by the Kaiser, as in the old days. The articles and advertisements are very significant and show that Germany's heart is unchanged. The principal contents of the June numbers are :—

No. 141.

A criticism of the Peace Conditions.—They are of course *unerfüllbar*.

Selbständige Wehrkammer.—Notice of a Society it is proposed to found independent of the War Ministry to defend the interests of the Armed Forces and keep alive Germany's warlike spirit ; no doubt this will include secret drilling and preparation for war.

Translation of Lord French's "1914".—With the passages that will please the German public in italics.

Situation in Russia and Poland.

Among the *Regimental Notices* is a list of officers of Infantry Regiment No. 18 who were killed in action ; the total is 80.

No. 142.

The *Decision of the O.L.H. (Higher Command) for the Offensive in the West*, 1918.—A determination to end the war by force of arms, as nothing more could be expected of Germany's allies.

Contribution to the Reconstruction of the German Army.—A discourse on training by a major of the War Ministry.

Translation of Lord French's "1914" (continued).

Among the *Advertisements* is a call for officers for "Dohna's Free Corps" to operate against the Poles in Silesia.

Roll of Honour of the Field Artillery Regiment No. 9.—51 officers killed in action.

No. 143.

The German Armed Forces in the German Peace Counter-proposals.—A very violently-worded protest by an old Lieut-General.

The decision of the Higher Command for the Offensive in the West, 1918. (continued).—A very interesting article. It is stated that the attack towards Amiens was stopped because the effect of surprise had been lost and too many men would have to be expended in continuing it by force ; that the attack in the Lys theatre was stopped because in the water-logged, devastated, and muddy plain, artillery could not get forward quickly enough ; the infantry, not sure of its support, hesitated or remained in the captured Portuguese Camps, and priceless hours were lost. No reinforcements came from Germany to replace casualties.

The Champagne theatre offered possibilities of surprise. When the attack at the Chemin des Dames succeeded, it was hoped to attack by surprise near Noyon, but it took 14 days to get the guns from the Chemin des Dames there and it failed. The object of the Marne and Champagne attack which was to capture Rheims also failed, and did not use up the French reserves as was expected. In July the numbers were 205 German Divisions against 170 French and English, 12 Belgian, and 20 Americans. If Germany resumed the pure defensive there was a good chance of losing the war. The effect on her allies had to be considered. She attacked on the Marne and failed from want of men who were denied to her by the Homeland.

Uniform and Equipment of the New Army.—Field grey is to be retained with various facings to distinguish arms:—Engineers, black with bright red piping as before; but all Infantry, white; Cavalry, golden-yellow; Artillery, bright red; Heavy Artillery, with golden-yellow piping. Rank will be shown by rings on the sleeves.

Roll of Honour of the 37th Fusilier Regiment.—91 officers killed.

No. 144.

Changes required in the Officers' Pension Laws.—There are apparently two rates applying to officers who retired before and after 1906. The recall of 'dug-outs' has caused anomalies.

The Enemy Situation in the Summer of 1918.—Combats the idea that the German Higher Command made miscalculations with regard to Marshal Foch's reserves and American assistance. It gives the German calculations of the British and French divisions available which seem correct, and shows that the number of American divisions was over-estimated up to February, 1918.

Roll of Honour of the 1st Guard Dragoons (formerly Queen Victoria of England's regiment).—19 officers killed.

No. 145.

Disbandment of the Old Army.—What remains of the Old Army is assimilated as regards regulations to the new *Reichswehr*. Volunteers for it are accepted to speed up demobilization.

The Circular letter of the Higher Command of 21st May, 1919.—Denies that the O.H.L. sent out a circular letter to find out whether the German people wished to continue the war rather than accept the peace terms.

Protest of the Reichswehr Brigade No. 3 (Lower Silesia) against a Disgraceful Peace.—The M.W.B. prints this with approving comments.

Correction to the English Report, "The Advance in Palestine and Syria."—Objects to the statement made in the work issued semi-officially in Palestine that Marshal Liman von Sanders fled from Nazareth before the British approach. Gives extracts from his war diary to show that he and his staff were actually surrounded in Nazareth, and fought their way out, the escort losing 1 officer and 42 men killed, 1 officer and 64 wounded, and about 10 officers with 250 men taken prisoners.

Roll of Honour of No. 13 Hussar Regiment.—21 officers, 31 N.C.O.'s and 292 men killed.

J. E. EDMONDS.

RIVISTA DI ARTIGLIERIA E GENIO.

May, 1919.

Auditory Zones and Zones of Silence.

La Rivista is engaged in the consideration of certain interesting phenomena caused by detonation, as for example, the double report and the air waves produced by the bursting of projectiles.

The acoustic phenomena of the war do not only affect the combatants, they are also of interest in districts far from the field of battle, and they attract the attention of students of acoustic phenomena, such as volcanic eruptions, which up to the present time have not been fully explained, while four years of war have allowed of the continuous and systematic observations which are necessary in researches of a scientific character.

References are made to a series of communications to the Academy of Science of Paris, to Esclangon, Perot, Schaffers, Collignon, and a study of the subject published in the Professional Memoirs of the Corps of Engineers, United States Army, and other sources.

The first and most obvious question in regard to acoustics in war is this: What is the greatest distance at which one can hear the sound of artillery fire? The reply generally given before the war, and also repeated by Esclangon, was that the distance was very limited, not exceeding 20, or at the greatest, 30 km. But certain sound phenomena that are noted in some points of the earth of a similar character to those of artillery cannonading are still unexplainable. Such sounds are attributed by some to the incessant work happening in the interior of the earth, comprised under the general name of seismatic rumblings, and better known under special names in different places, Mist-puffers in Scotland, Mispoeffer on the Belgian coast, Neberlzerteller in the North Sea, Bramidos on the delta of the Ganges, etc.

It is a remarkable fact that these mysterious sounds happen only on the coasts during calm weather with a high temperature and with determined winds, and never under other conditions, circumstances especially strange for rumblings from the interior of the earth. Now, Bigourdan cites some examples to show that the fire of artillery can be heard at greater distances than those above quoted.

In the trials made in 1736 by the Academy of Science at Paris, between Montmartre and Monthery on one side and between Montmartre and Dampmartin on the other, the firing of guns was heard at a distance of from 28 to 31 km. Such distances extended to 50 km. and more in the trials made in Italy by Bianconi in 1740. Four years after at Cayenne the fire of guns was heard at a distance of from 12 to 40 km. But the limits of the auditory zone can be extended to more than four times this distance, as full confidence may be placed in the statement that, in 1867, salvoes of artillery, fired at a great Naval Review at Spithead, were heard at distances varying from 170 to 180 km.

Bigourdan adds that we are not cognizant of the law under which the greatest distance of perception varies with the weight of the charge; he supposes that it may vary with the square of the weight of the charge, and he shows how, with heavy coast guns, it may extend from 200 to

250 km. Others affirm that the calibre of the gun and the weight of the charge have not much influence on the auditory distance.

The acoustic phenomena in war are very complex, since in addition to the firing of artillery there is a second category of explosions caused by the air being violently affected by the passage of projectiles; and also a third, the explosion of projectiles and mines.

Esclangon maintains that in the cannonading in this war, at considerable distances from the front, it is not the sound of firing from the guns or mortars, or the bursting of the shells that strikes the ear, but only the sonorous waves (*andes de choc*) produced by the passage of the projectiles through the air.

It may be considered certain, according to Bigourdan, that the sound of cannonading has been heard in the present war at very considerable distances—some hundreds of kilometres.

In the first months of the war, Professor Van Everding, of the Utrecht University, noticed at Groninga, at 270 km. distance, the sounds of artillery fire from the forts of Antwerp, and with the development of the action, rumblings were heard at London, Caen, Mortain, Bagnoles de l'Orme, Blois, Bourges, Nevers, Baune, Verdun-sur-Doubes, Annecy, and Chamonix. Now, the shortest distances of such localities as Mortain or Bourges from the front are about 300 km.

From minute and precise observation made during the three years, 1915, 1916, and 1917, from Collignon, at 170 km. distance from the Arras front, from St. Quentin, and from Lassigny, and published in the *Comptes Rendus* by the Academy of Science at Paris, it was ascertained that the phenomena of sound at great distances are subject to laws of annual and daily periodicity. The favourable season for the transmission of sound is from May to September; in other months no rumblings were heard. In a period of three years there was only one exception to this law, from the 3rd to the 9th March, 1917, while in March, 1918, in spite of the most intense fire of the great German offensive, at Louviers the sound of cannon was only rarely heard. During the whole of the summer and autumn of 1916, the rumbling of cannon on the Somme was very intensive and persistent in Sussex. Now, in June and July of this year, the wind constantly blew from the west, and in August, September, and October, it seldom came from the east. In the winter and successive spring, exceptionally cold seasons, the sound of guns was not heard, even during the British offensive at Arras in April, 1917. In the summer, the sounds were again heard, less frequently than in 1916; but there was not a single instance when the wind was from the east. The sounds called Mispoeffers, heard on the Belgian coast, and of which a list was made, were only audible when the temperature was high.

E. T. THACKERAY.

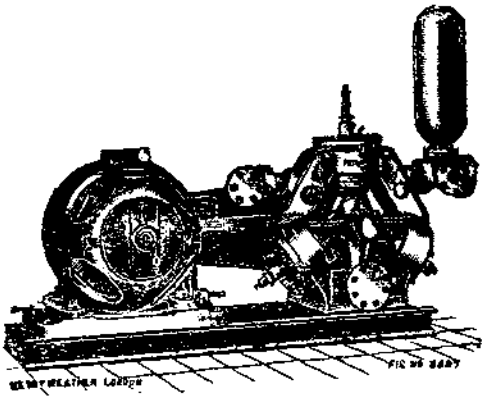
(To be continued.)

MERRYWEATHERS'

PATENT

"HATFIELD" PUMP

IN STATIONARY OR PORTABLE FORM.



Specially adapted for working with Electric or Petrol Motor.

Constructed in several sizes.

Renowned for its great lifting powers without priming device.

An efficient high pressure pump at low cost.

Write for particulars.

MERRYWEATHER & SONS

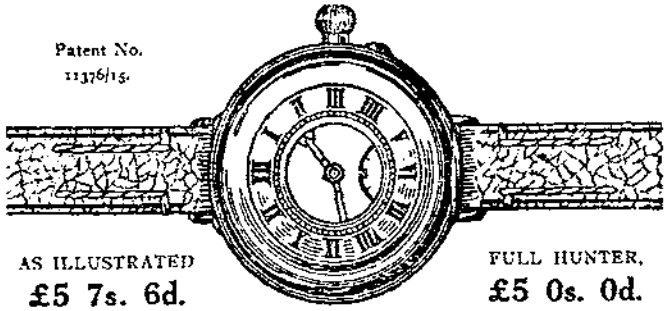
FIRE ENGINEERS,

GREENWICH, S.E., LONDON.

JEWELLERS & SILVERSMITHS TO H.M. THE KING

The "Military" Luminous Watch.

Patent No. 11376/15.



AS ILLUSTRATED
£5 7s. 6d.

FULL HUNTER,
£5 0s. 0d.

THE "Military" Luminous Watch illustrated is fully luminous at night, and is contained in a one-piece solid silver screw case that makes it dust and damp-proof: it is fitted with a patent cover to protect the glass. An accurate timekeeper, this watch is indispensable for Naval or Military Service, being of highest quality and of proved reliability.

THE
GOLDSMITHS & SILVERSMITHS
COMPANY LTD. *with which is incorporated The Goldsmiths Alliance Ltd. Ltd.*

112, REGENT STREET, LONDON, W.1.