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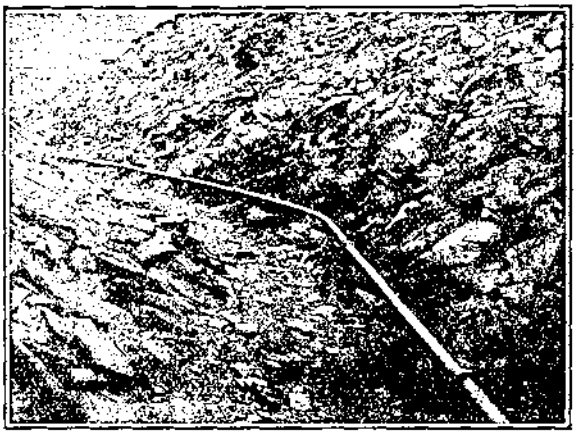

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AIRSHIP DEVELOPMENT.

A Lecture delivered at the S.M.E., Chatham, on 22nd November, 1928, *by* GROUP CAPTAIN P. F. M. FELLOWES, D.S.O., *A.D.C.*, R.A.F.

I FEEL much honoured to have been asked to lecture on the present development of British airships in what is essentially their source of origin. One of your Corps, who has been connected with airship development for over 25 years, is still with us, and occupies the important position of Chief Inspector of the Aircraft Inspection Department for the Cardington airship.

The subject of airships is a somewhat wide one to endeavour to include in a single lecture, and naturally divides itself into four subdivisions: *Construction, Operation, Commercial Uses* and *War Uses.*

Before I deal with these headings, you would probably like to be reminded of the main points of our present programme. We are building two 5,000,000 cubic ft. rigid airships, one at Howden and one at Cardington, and are laying out sheds (docks) and mooring towers (harbours) at suitable places within the Empire, to enable these ships to be fully tried out in varying climatic conditions. At the same time, the necessary meteorological investigations are taking place, and arrangements are being made to instal adequate communications. Summarized, the main object of the programme is to prove to the business community that airship hulls can be built strong enough to operate regularly, and that therefore airships are worth while from an economic point of view.

CONSTRUCTION.

Taking construction first, I will show you some slides of the various types of ships which have been built with the purpose of bringing out their main differences. Before I show you these slides, I will remind you that the lift of hydrogen at ground level under standard conditions is 68 lb. per 1,000 cubic feet, a convenient figure to remember is that 33,000 cubic feet will lift a ton. The buoyancy of an airship is equal to the weight of air she displaces. It therefore decreases as the air density decreases with increase of temperature or height. Consequently an airship has less lift or gas capacity in hot climates or at heights, than in cold weather or at ground level. By flying an airship bow up or bow down, an upward or downward

dynamic lift may be produced, which in R.101 at full speed will amount to 15–20 tons.

My main object in showing you this series of slides is first broadly to emphasize the different types of ships and then to bring out the development of shape which has since taken place in the rigid. The originator of the rigid design, as you all know, was Count Zeppelin, and in the first instance he built a long, cigar-shaped, parallel-sided airship, as being the easiest type to construct. Probably, also, he did not realize that the fat, squat shape was better aerodynamically. It was in 1894, when he was 56 years old, that he commenced to design his first rigid ship. She was ready for flight by 1900, and by 1906 he had achieved what could be described as a really successful rigid airship. Before the War, with a total of six commercial airships, of which three were damaged and written off during the trial period, he carried 37,250 passengers in a total of 1,600 flights over a distance of 90,000 miles, without accident to a single passenger.

The Germans have built considerably over 100 rigid ships, and finally, at the present time, they have recently completed LZ.127, of 3,700,000 cubic feet capacity.

We built nine rigids and 213 non-rigids, and we are now engaged in building two rigid ships, R.100 and R.101, of 5,000,000 cubic feet capacity.

The Americans have put out competitive tenders for designs of two ships of about 6,500,000 cubic feet capacity.

The Italians and Americans and the French have also, in the past, built and operated airships of various types. It will, therefore, be realized that there is a considerable amount of experience available throughout the world, both in regard to the construction and operation of ships, as they have been in serious use for almost 30 years. At the same time, it would be unwise to disguise the fact that there is a great deal still to be learnt, both in regard to construction and operation. The construction of airships, due to the pressure of war, had to proceed faster than scientific investigation. Due to this pressure, it was found to be impossible to devote sufficient time to research into the problems involved, and it is only since the War that this time has become available.

Largely as a result of the accident to R.38, and arising out of the recommendations of the committee who sat to investigate this accident, an extensive programme of research into the problems involved in the design of airships has been conducted in Great Britain during the last few years.

The object of the investigation was to discover the aerodynamic forces acting upon an airship while in flight and at the mooring tower, and to ascertain how and to what extent these forces and the static forces due to loading, set up stresses in the structure. The aerodynamic forces were investigated by means of model tests in the

wind tunnel and full scale tests in flight in R.33 ; these results were incidentally found to agree closely.

The forces in an airship having been computed, it remained to discover how the primary stresses distributed themselves in the structure. Investigations on a simplified model were carried out to test the value of the theoretical conclusions come to on this subject, and published in a memorandum, *R. and M.* 970, issued by the Aeronautical Research Committee. These investigations generally confirmed the theoretical conclusions, and enabled the Committee of the Airship Panel to lay down factors of safety to which the new airships should be built. Further, to confirm the accuracy of the methods in use, and also to measure the secondary stresses, a complete test bay consisting of two full-size rings connected up by longitudinal girders of R.101 was erected and fully tested for all the stresses they could be put to in flight. The stresses were computed on the results obtained by a number of specially constructed strain-measuring gauges incorporated in the structure. The girders used in the test bay were then tested to destruction singly and in families, to discover the possible variations in strength in any particular girder.

The new ships, during their flight trials, will have incorporated in them a large number of pressure points on the exterior of the hull and also a large number of strain-measuring gauges in the structure, which will enable the stresses, set up by actual aerodynamical pressures in flight during rough weather and all types of manœuvres, to be measured and their incidence compared.

In order to enable this to be done, a governing essential of the present programme has been that the airship hulls should be built too strong rather than perhaps not quite strong enough. It would not be overstating the case to say that the primary object of the programme will have been achieved when these hulls have been successfully constructed, flown, and fully tested.

I will now show you some of the slides of the structure of the two new ships, and point out to you the advantage of the stiff ring for R.101, the system which has been evolved to transmit the lift from the gasbag to the structure for both R.100 and R.101, and how this system does away with the disadvantage of the lateral loading of the girders by the gas lift, and also how it is possible to transmit this gas lift direct to the requisite points in the structure.

Part of the policy of the Government has been to produce, as the result of this programme, two competent airship designing staffs. In order to do this, no detail information in regard to the two designs has been exchanged, but only information fundamental to the design of rigid airships. It is interesting to see the result of this policy in the actual design of the two ships.

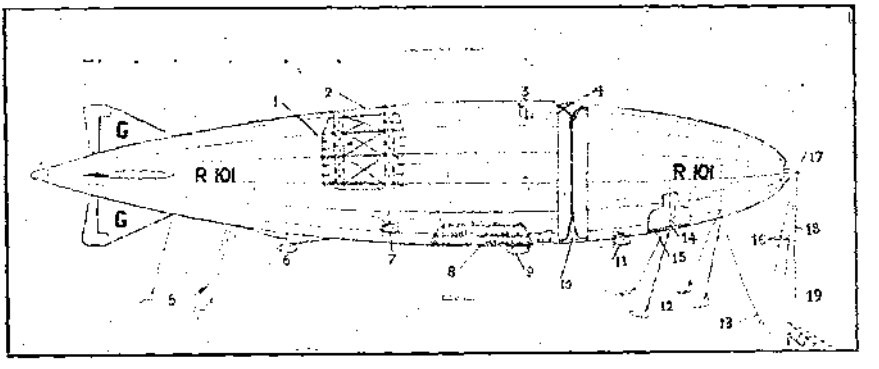
Both designers have, as I mentioned before, eliminated the previous

difficulties of transmitting the gas lift to the structure without stressing laterally the girders of the ship.

In addition, in R.100 the effect of the secondary stresses from ring to longitudinal, which occur in the Zeppelin type, have been very much reduced by means of a very ingenious type of joint.

In R.101 this type of joint is not necessary, as the stresses which occur in R.100 are allowed for by the gasbag wire suspension in another way.

In R.100 the passenger accommodation is built up in a separate unit, and slung in one bay of the airship. In R.101 the passenger accommodation has been placed in the lower part of the ship, and actually built into the structure of the ship. At the same time, in both ships arrangements have been made whereby no stress inherent in either structure can be transferred from the ship to the passenger structure or *vice versa*.



1. Reefing boom.
2. Framing exposed.
3. Observation platform.
4. Gasbags exposed.
5 & 12. Handling guys.
6. Power car.
7 & 11. Power car, port and starboard.
8. Passenger accommodation.
9. Control car.
10. Mails and goods space; also at frame 10.
13. Trail rope.
14. Side gangway entrance.
15. Main corridor from bow to passenger accommodation; on port side only.
16. Side guy wires.
17. Bow mooring gear.
18. Main mooring wire.
19. Coupling.

The designer of R.101 has also introduced stainless steel into the structure of the airship, steam heating for the passengers, and a system whereby the airship can have her trim altered by blowing ballast from end to end of the ship by air pressure.

In both R.100 and R.101 allowance has been made for the type of stress which mooring at the mooring tower introduces. These stresses actually are the governing factor in the strength of the ship for the first third of the length of the ship.

As I mentioned before, model tests in the wind channels at N.P.L. were carried out early in the programme. By means of these tests

the most efficient shape, fins, power bodies, etc., were ascertained. Actually the shapes of the two designs are very similar, but in matters of detail in regard to the shape of the fins, the placing of the power bodies, the control car, etc., the designers have varied a little.

These two ships are the first airships which have ever been built to specified factors of safety, and are probably three or four times as strong as any previous rigid airship built.

The meteorologists, by means of calculation in regard to the size of hailstones, inform us that vertical currents in the centres of thunderstorms with speeds of up to 7,000 feet per minute, occur in very phenomenal storms, but recommend that 4,000 ft. a minute is a safe figure to allow for. Both R.100 and R.101 have, therefore, been built to withstand a rate of rise of 4,000 feet per minute. You will, no doubt, appreciate that this rate of rise and fall introduces rather drastic considerations in regard to the release of gas from the bags and the release and entrance of air from and into the interior of the hull. No good airship captain would ever take his ship into an area where such conditions prevailed, and I have merely given you this as an illustration of the extreme caution of the policy governing the construction of these ships.

A point on which we are not yet clear is as to the rate of change of velocity and rate of change of direction of wind gusts in abnormal conditions.

These variations in the structure of the atmosphere, particularly those which occur close to the ground, are vital factors in the consideration of the strength which should be embodied in the hull of an airship, especially when lying to a mooring tower. A full scale meteorological investigation to ascertain these conditions is now in process at Cardington. Four synchronized anemometer masts, covering the area which would be occupied by a modern airship, have been set up at Cardington to enable such wind structures to be analysed. This investigation is not yet complete, but as far as it has gone, it has tended to show that conditions are not as bad as we had allowed for. The calculations as to the stresses likely to be set up, based on these results, will be confirmed in actual practice when the airship lies at the mooring tower.

Several innovations, other than in the structure, are being introduced into these new airships. For instance, in R.101 it is hoped to fit the engines with a variable-pitch propeller, which will not only enable the pitch to be varied so as to obtain the greatest propeller efficiency for the number of revolutions run, but will also enable the propellers to be used for checking the headway of the airship as she approaches the tower, without reversing the engine. The engines themselves in R.101 are to be heavy oil or Diesel engines. This does away not only with risk of fire from carrying petrol, but also with the complications of magnetos, sparking plugs, etc. The engines

we are using for R.101 are the first experimental type, and consequently may give trouble. They are also very much heavier than petrol engines, the 650 h.p. engine we are using weighing 4,600 lb. —nearly 8 lb. per h.p. The heavy oil engine will probably always be heavier than the petrol engine of the same h.p., but as it burns a smaller weight of fuel, it is even now superior to the petrol engine for long flights.

The risk of fire with heavy oil fuel is negligible, the flash point of this fuel is 210°, and it will actually put out petrol fires.

The engines in R.101 are steam and not water-cooled engines. The steam of two of the engines is used for heating the passenger accommodation and supplies ample heating for the purpose.

R.100 is to be equipped with Condor engines at first, but it is the intention to re-equip her with heavy oil engines later.

The electric generators are operated by a small auxiliary engine, or alternatively by a windmill which maintains a constant speed whatever the speed of the airship.

Other developments which will be introduced for future ships, but will not be tried out at first, are hydrogen burning in the engine and water recovery. At present, as we burn our fuel as we proceed on a voyage, gas has to be valved and therefore wasted. Water recovery would partly eliminate this waste, and hydrogen burning in combination would completely do so.

The passenger accommodation embodied in both R.100 and R.101, while not up to the standard achieved by the modern liner, is not far short of it in some respects. The largest room, for instance, in R.101 is some 65 feet by 35 feet, while, if the cabin accommodation is on the small side, the beds will be comfortable. Ordinary meals will be supplied, cooked on electric cookers, while all ordinary amenities, including shower baths, are available.

I will now pass from construction to operation, but I have naturally only been able to touch upon the main points, and if anybody wishes to know anything else, I hope they will question me after the lecture.

OPERATION.

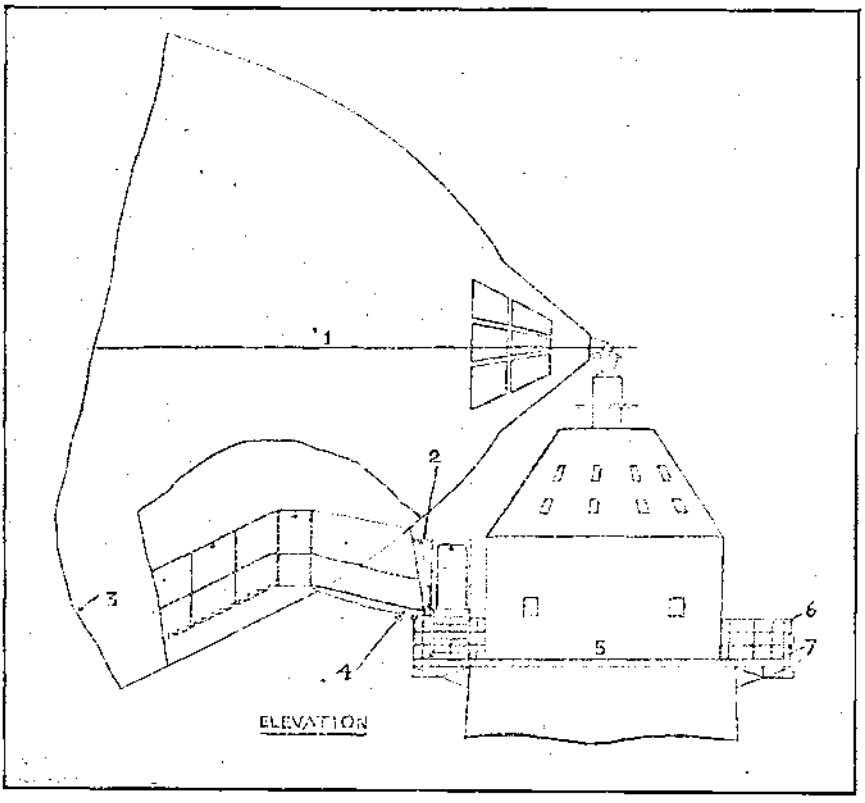
There are a great many factors to be considered under this heading. The first and most important is economy of effort.

In the past, airships had to be handled and operated from sheds. This is most uneconomical. At the end of the War, efforts were made to develop the mooring mast, as it was then called, but it was not until 1921 that a system, known as the vertical system of approach, was evolved, by means of which an airship was enabled to approach and moor up to a mooring tower. With the old ship R.33 they proved that airships could moor up in winds of 30 m.p.h., remain at the mooring tower in winds up to 60 m.p.h., and leave the mooring

tower in winds of 40 m.p.h. These results will, no doubt, be much improved upon in the future.

I will now explain the mooring tower system to you with lantern slides.

In regard to the handling of airships into airship sheds, you will realize that this is a very difficult and delicate operation with ships of the size of R.101. The lateral or broadside surface of the ship will be something in the order of 70,000 square feet, as compared



1. Axis of ship.
2. Adjustable platform on mast to suit ship.
3. To passenger accommodation amidships.
4. Combined slide and rollers (running round on rail). Taking hinged gangway of ship.
5. Passenger platform.
6. Rail.
7. Metal sheet weather dodger.

Diagram of bow mooring system

with the end-on surface of something like 13,000 square feet, and at the same time this vast object, it must be remembered, although it has a mass of 150 tons, has no weight. That is to say, from the control point of view, it is the equivalent of an enormous feather. Realizing this, you will see the limitations imposed by the winds upon handling airships into sheds. The Germans say they have

handled ships into and out of sheds in winds up to 25 m.p.h. in a direction nearly parallel to the sheds, when using handling trollies running on rails fixed in the ground; but in Great Britain, by the system we at present use, we would not attempt such a feat, and to handle a ship of that size into a shed, in winds not exceeding 10 miles per hour, takes anything between 400 to 700 men. The advantage of the mooring tower, with its crew of 14 men, therefore becomes very obvious in regard to economy.

In the present programme, mooring tower bases are being erected in England, Egypt, India, Canada, South Africa, and various sites have been surveyed in West and East Africa, Ceylon, Cocos Islands, Australia and New Zealand. Until bases throughout the Empire have been set up, it will be impossible to utilize airships for either commercial or military purposes.

But it is not only bases which are required; until the necessary meteorological arrangements and communication system have been organized, it would be unsafe to operate airships. Therefore, the object of the present programme is gradually to bring into being the necessary bases, communications and meteorological organization, so that airships may be operated safely within the Empire.

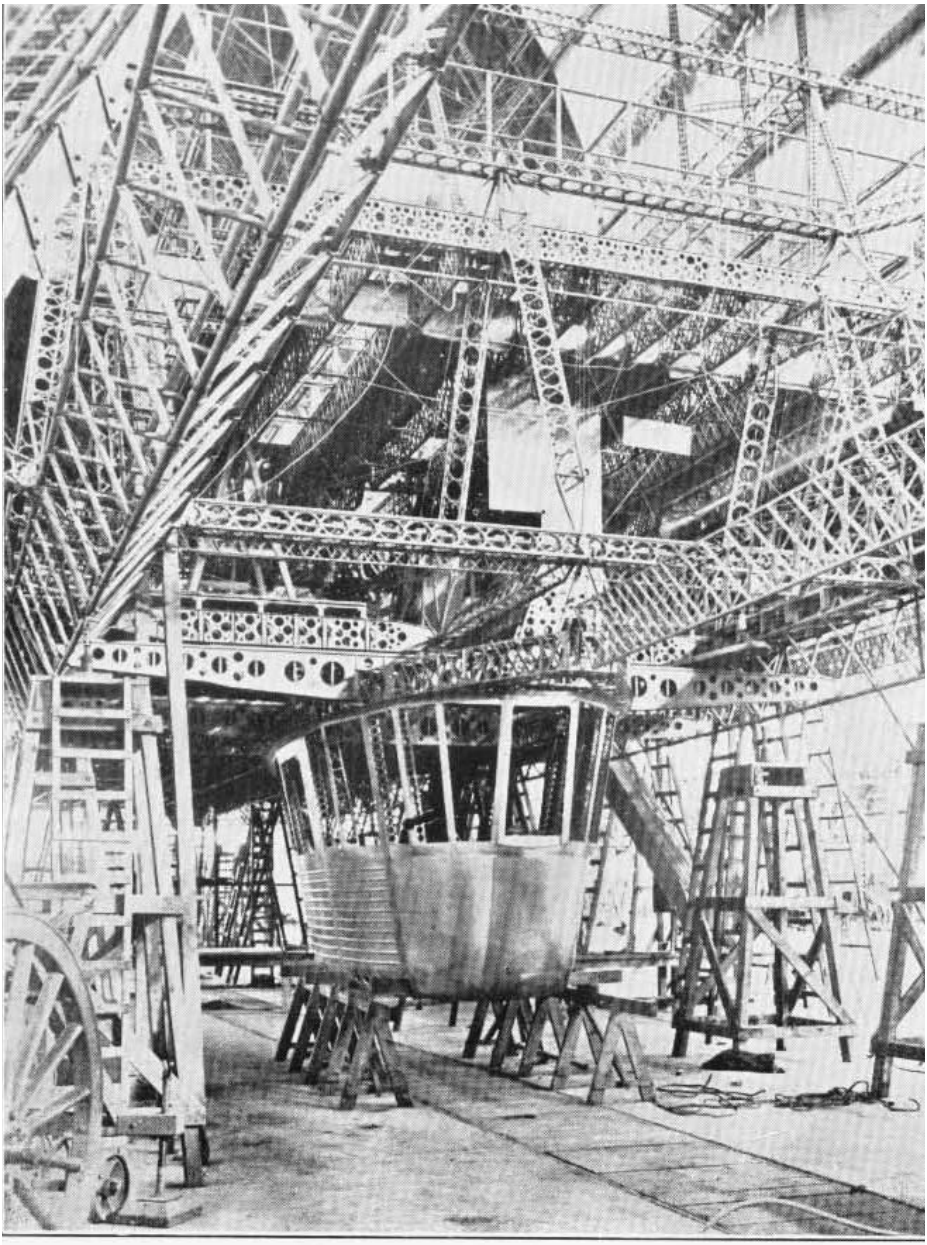
The importance of the science of meteorology to the operation of airships it is impossible to exaggerate. With airships, navigation and meteorology are inseparable.

Not only have the bases to be selected for the local conditions which prevail, but also for the conditions which normally prevail in their approaches. I will give you one instance to illustrate this point. Visualizing the map of the world, the obvious route for airships to Australia would appear to be from England–Egypt–India, from thence to Singapore and thence to the North of Australia; but this route is most undesirable from the airship point of view, not only because of the prevailing winds, but also because of the thunderstorm belt which is continuous to the North of Australia.

Similarly, mooring tower bases in the North of Australia would not be as suitable as mooring tower bases in the South of Australia, due to the fact that the area in the North is the hot area. Airships would not only have less lift, but air is more unstable in these areas, and also the cover and bags of airships deteriorate more rapidly in hot climates.

You probably all know that in certain areas of the world seasonal and prevailing winds are normal. They were the winds used by the old sailing captains, and they will be the winds used by the future airship captains.

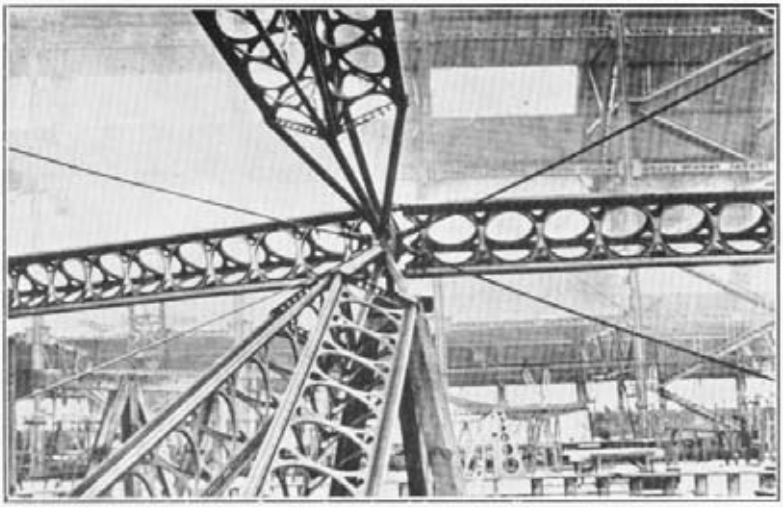
Take the route from the Cape to Australia; the "roaring forties" or Westerlies will help the airship at a high speed from Capetown to Perth, by keeping south. Equally so, the S.E. Trades will help the airship from Perth to the Cape, by keeping north.



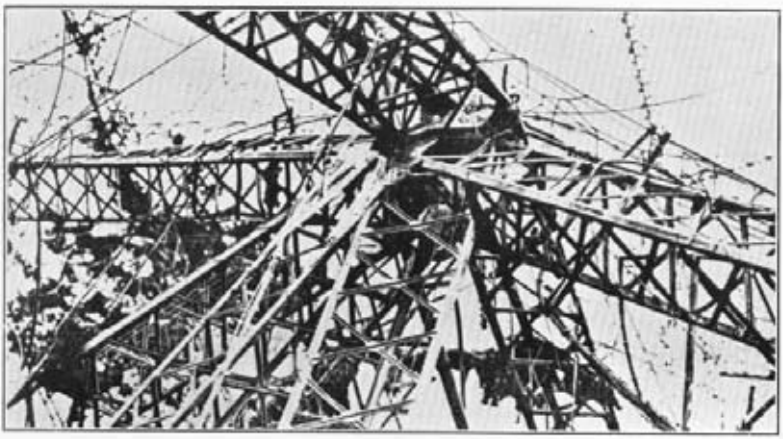
Control car R101.

AIPSHIP DEVELOPMENT

Types of Structure.

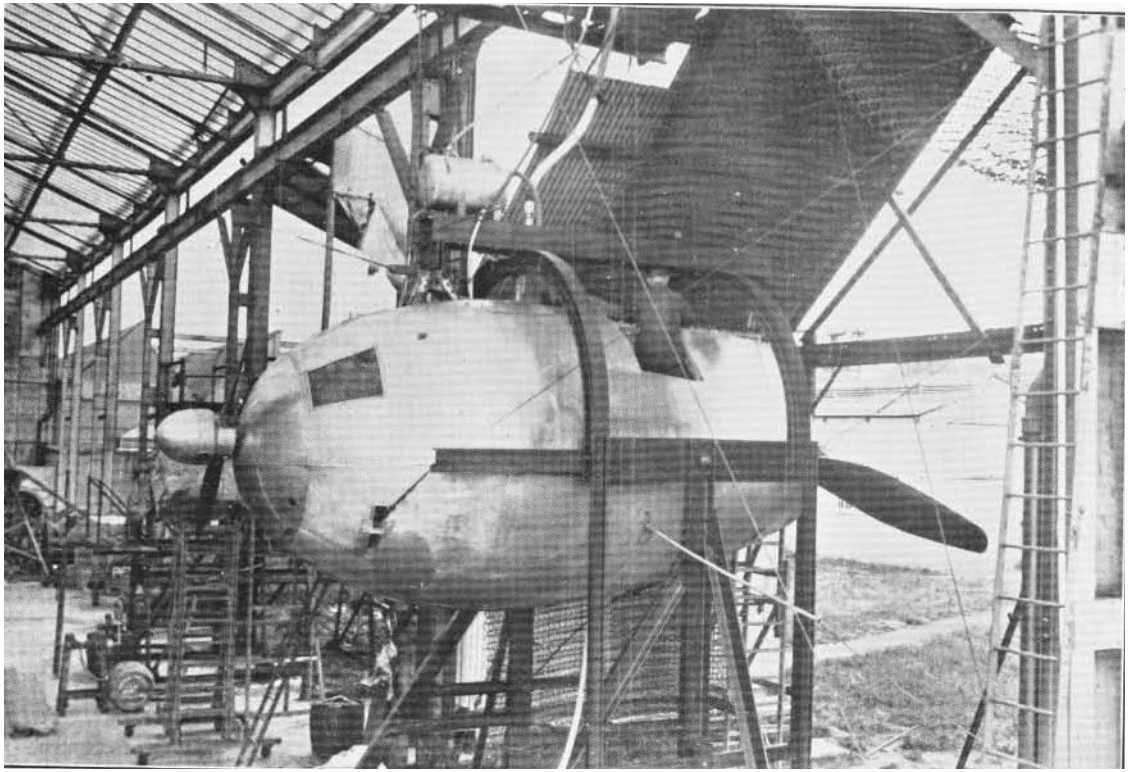


R101 type.

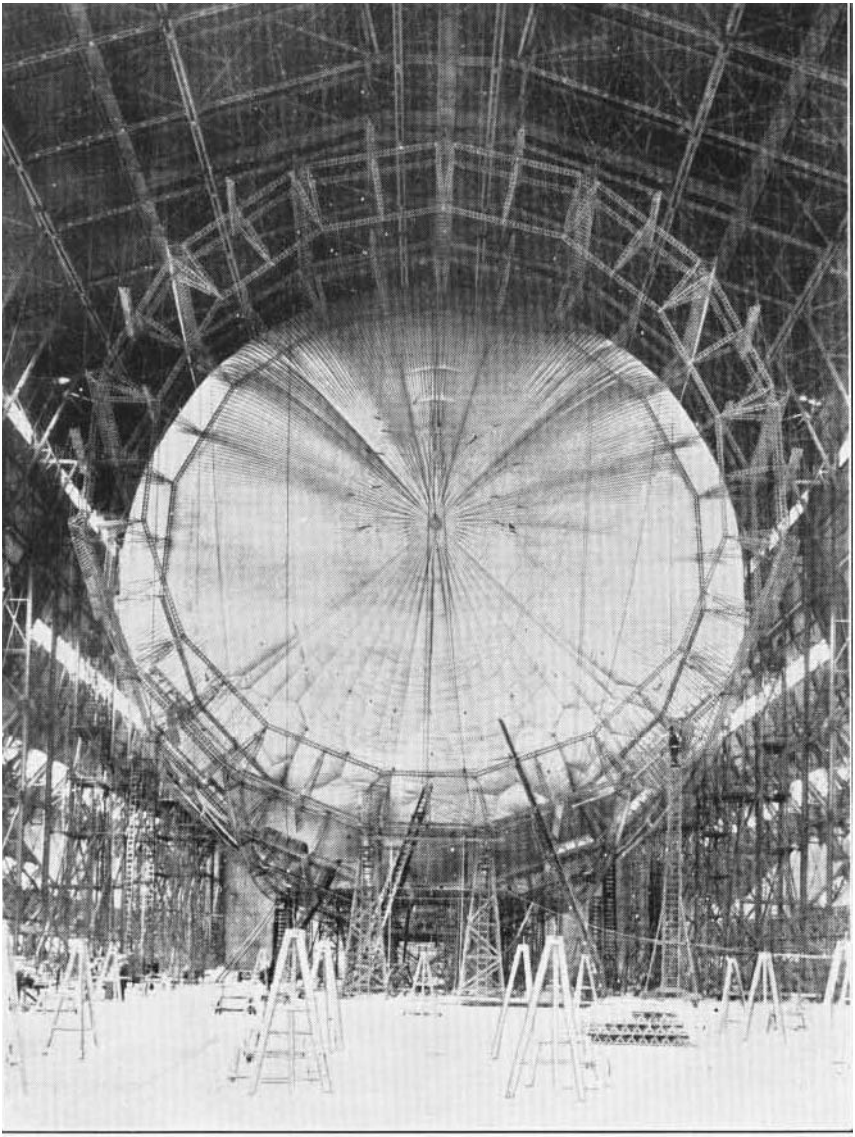


Zeppelin type.

ZeppelinType



PowerBody of R101



Gas bag inflated in R101 during construction.

Gas Bag

I have mentioned thunderstorms, so I think it would be desirable to explain to you that thunderstorms are not the serious matter to rigid airships that they are generally thought to be, in so far as the actual lightning is concerned. Rigid airships have frequently been struck by lightning in the past, and the only known effect has been partially to fuse the metal of the structure at the point of entry of the flash. The cross-section of the metal of the structure, which forms a continuous Faraday cage around the whole of the ship, is amply large enough safely to convey the amperage transmitted by a discharge. It is generally agreed that these discharges, and also the gradual change of potential due to alteration of height, etc., are conveyed away through the engine exhaust. How dangerous to airships the vertical currents of air which occur high up in thunderstorms and line squalls may be yet remains to be proved, but we believe we have made ample allowance for them in the structure of the ship. The experienced airship captain will avoid these upcurrents by flying low when in the neighbourhood of these conditions, and will thus avoid high speed vertical currents and also the one real danger in a thunderstorm, which is the necessity to valve gas.

Our meteorological branch have been analysing the conditions which have prevailed on the routes on which the airships will first fly, for several years, and the airship staff have been carrying out theoretical exercises in flying an airship with similar speed to R.101 over these routes, utilizing the actual weather conditions which existed in past years; that is to say, in November of this year they will be using conditions in carrying out their exercises, which actually occurred in Novembers of past years. These exercises are not only providing our airship staff with the same type of experience as that which they will gain in actual flight, but are also practically teaching them the weather map of the world in the neighbourhood of the routes over which they will have to fly.

Commercial Considerations.

The first consideration in commerce is, of course, profit; but before profit can be achieved, safety, reliability, and punctuality have to be demonstrated. A very distinguished authority in the commercial world, Sir Alan Anderson, has told us that airships, within limits, can largely disregard expense provided they can ensure these three factors, safety, reliability, and punctuality, because the great increase of speed which airships will be able to bring about in communications is of such vital importance. With the ships we are now building, it is anticipated that Egypt will be within two days, India within 4¼ days, Australia within 11 days, and New Zealand within 14 days of Great Britain.

What this means to the world it is impossible to foresee, but that

it will have a great effect is unquestionable, and it would be an interesting exercise for the imagination to take the existing map of the world's steamship routes, and even railway routes, and endeavour to forecast how much they will be diverted in the future by the effect of not only airship but also aeroplane transport.

There are certain commodities in commercial transport which can afford to pay for fast transport: they are passengers, mails, specie and valuable light freight generally, and it is these very commodities which the airship can conveniently carry.

I was much struck by the point of view of Dominion business men during my recent tour. In their view, the most important service the airships could render the Empire was not that of mail carrying, but that they would enable important business heads to meet personally with considerably greater frequency than they could achieve at present.

The present programme of building two airships is obviously only a very small beginning. These two airships can, at most, obtain certain data for the commercial brains to consider. I very much doubt if two airships will be able to obtain sufficient, because it seems to me that before commercial organizations can spend the money of their subscribers on airship development, they will have to have a very clear line to go upon, both in regard to reliability and expense. If, say, running these two experimental airships over the route between England and India for one year, to a regular but not very frequent time-table, is sufficient to convince the shipping interests that airships are a potentially serious rival, then two airships are probably sufficient; but the mind of the world is very loyal to its old convictions, and I think it will be necessary for airships actually to commence to affect traffic receipts before they will obtain very important business consideration.

Airships are, unfortunately, rather expensive because of their great size, and people are rather apt to think because we have been a long time in producing these airships, that therefore they ought to come out perfect, but naturally this cannot be so any more than is the case with the first of a new type of motor-car.

The expense of their bases I do not think will seriously matter, as it will be so obviously to the interests of the local authorities to erect them that this will not, I think, affect the rate of development of airships. But the expense of the construction and maintenance of the early type of large airship may act as a serious deterrent to commercial organizations at the commencement of their development. This still remains to be seen, but each airship shed, in which to construct a large airship, costs somewhere between £150,000 and £180,000, and there are at present in existence in England only four sheds in which it would be possible to construct a 5,000,000 cubic feet ship, and only two of these are big enough to operate airships from.

When these two ships commence operations, one of these two sheds will have to be retained as a dock for airships in England. Similarly the shed in India will also have to be retained for such a purpose. It is, therefore, clear that there are only, at most, three sheds available for airship construction at present in the Empire, and in only one of these can a ship be built of over 5,000,000 cubic feet.

So far I have not mentioned the Anglo-Canadian route. This route, due to the weather conditions which prevail between England and Canada, requires a larger airship for its operation than the Eastern route. Our analysis of the weather prevailing led us to believe that a ship to operate this route will have to be of considerably larger size than those now being built. The one shed I have mentioned above would probably be sufficiently large in which to construct such a ship, if some concession in regard to the perfect length/diameter ratio were made.

Surveying the development of airships for commercial purposes in sight at the moment: England is building two definitely for commercial development; the United States have accepted a tender for the construction of two large airships for naval development, but these ships could be used to establish the commercial possibilities of airships; Germany has built one large rigid of nearly 4,000,000 cubic feet, built solely for commercial purposes. Spain and the Argentine have investigated the preparation necessary for the development of commercial airships.

You will see, therefore, that the basis for the commercial development of airships on a large scale is still very meagre. How quickly it will come about really depends, as I have said before, upon the capacity of these first airships to satisfy commercial minds, such as shipowners and bankers, of the desirability of pressing forward quickly with airship development within the British Empire. If they consider that the airship will develop into a serious competitor to the surface ship in regard to passengers, mails, etc., they would be most unwise to allow other nations to catch up on the start we have obtained by embarking on the present airship programme; but, naturally, sober-headed men, such as the heads of our big shipping organizations undoubtedly must be, must have serious proof before they can move, but there can be no doubt that the right people to move, when the moment arrives, must be the big shipping organizations. They have the experience of handling large craft, and they have the office organization throughout the world to deal with the administration, upkeep, etc., of such craft.

A business man suggested to me the other day that airships are now in much the same position in regard to steamships as the wireless companies were to the telegraph companies some years ago. We all know who held the trump cards in the recent negotiations for the

merging of these two interests, whereas, had the telegraph companies displayed real foresight twenty years ago, they would never have fallen into this unfavourable position.

Military Uses.

If we leave weather conditions out of account—they must, of course, always affect the operation of airships as they do surface ships, but I think they, due to our greater knowledge of airship design and to the perfection of our meteorological arrangements, may be largely discounted—the military uses of airships are, in my opinion, all dependent upon the undoubted vulnerability of the airship. In the last war, before aeroplanes were developed, the Zeppelins were utilized successfully for bombing, but now that not only the aeroplanes but ground organizations for locating aeroplanes and airships, listeners, etc., have been developed, in my opinion, the use of airships for bombing areas defended by aircraft is suicidal, and can never produce total effects which work out in favour of the attacker, as his constructional efforts and organization to produce an airship fleet must always be greater than the total disorganization, etc., which he causes to his enemy.

But if it is accepted that airships normally will not be used in areas which are controlled by enemy heavier-than-air aircraft, it by no means eliminates the airship for war purposes.

In any war in which we engage, there must be large areas of the world friendly to ourselves, and at present the oceanic areas cannot be regarded as areas under control by aircraft. Therefore, for a large number of communication and reconnaissance purposes, the airship is still a valuable war auxiliary.

It would not be logical to agree that the airship, because of its vulnerability, could not be used for such purposes, when we at the same time face the fact that the merchant ship, an equally vulnerable craft, is vital to our existence in these islands. Therefore, when airship bases are established throughout the Empire, there is little doubt that the airship will be a most important means of communication in war, for dispatches, staff officers, light stores, aircraft transport, and even troop transport.

With regard to the latter, it may come about in the future that the War Office will make arrangements whereby the stores for the equipment of troops, etc., will be held in outlying bases so that the troops to use them can be transferred quickly by light and fast transport. If this is done, the economy in the defence of the Empire may prove to be of great importance, as it will no longer be necessary to maintain such large peace garrisons abroad.

Airships will not normally be used for purely offensive purposes, but there are certain cases in which they could be so used with great

effect. They are:—For the control and, if necessary, bombing of merchant ships in war, and for a similar purpose in regard to inhabitants of territories unarmed with aircraft.

The possibilities of an airship as an aircraft carrier, from which aircraft can drop off and hook on again any number of times, has yet to be proved under normal service conditions. The actual manœuvre of hooking on has been successfully achieved in both this country and in America, but the system and apparatus still require considerable development. There is no difficulty whatever in dropping off in an aeroplane. When the airship carrier comes into being it will largely supplement the surface aircraft carrier, over which it has some considerable advantages.

Airships will probably be able to carry half, or perhaps more, of their total dynamic lift in aircraft, when they are used as aircraft carriers. We are not certain yet how much an aircraft will support itself in the air at the normal cruising speed of an airship. When used as an aircraft transport, airships will be able to absorb their full surplus lift in carrying aircraft, and it is conceivable that more aircraft will be able to embark after the airship is in the air.

The difference between the carrying power of an airship carrier and an airship transport is brought about by the fact that the former cannot valve gas because she has to re-embark her aircraft in the air, whereas the latter can valve gas as she finally gets rid of her aircraft on arrival at her destination. The airship carrier after dropping her aircraft, maintains herself below her pressure height, or height at which she would have to valve gas and so lose lift, by using her dynamic lift. That is, she sets her elevators to drive her down.

When the airship carrier and transport has been developed, many uses for such craft will be found both for defensive and offensive purposes for Air Force and naval operations.

It has been suggested that airships will be used as hospital ships. So far as comfort is concerned, there is no reason against this use, but the difficulty of timely recognition under certain weather conditions may prove an insuperable objection.

THE 23rd (FIELD) COMPANY R.E. IN THE GREAT WAR, 1914–1918.

(*Continued.*)

By MAJOR R. L. BOND, D.S.O., M.C., R.E.

PART IV.—OCTOBER, 1915—FEBRUARY, 1917.

Battle Honours during the period—" Somme 1916," *" Albert* 1916," *" Bazentin," " Pozieres," " Flers Courcelette," " Morval."*

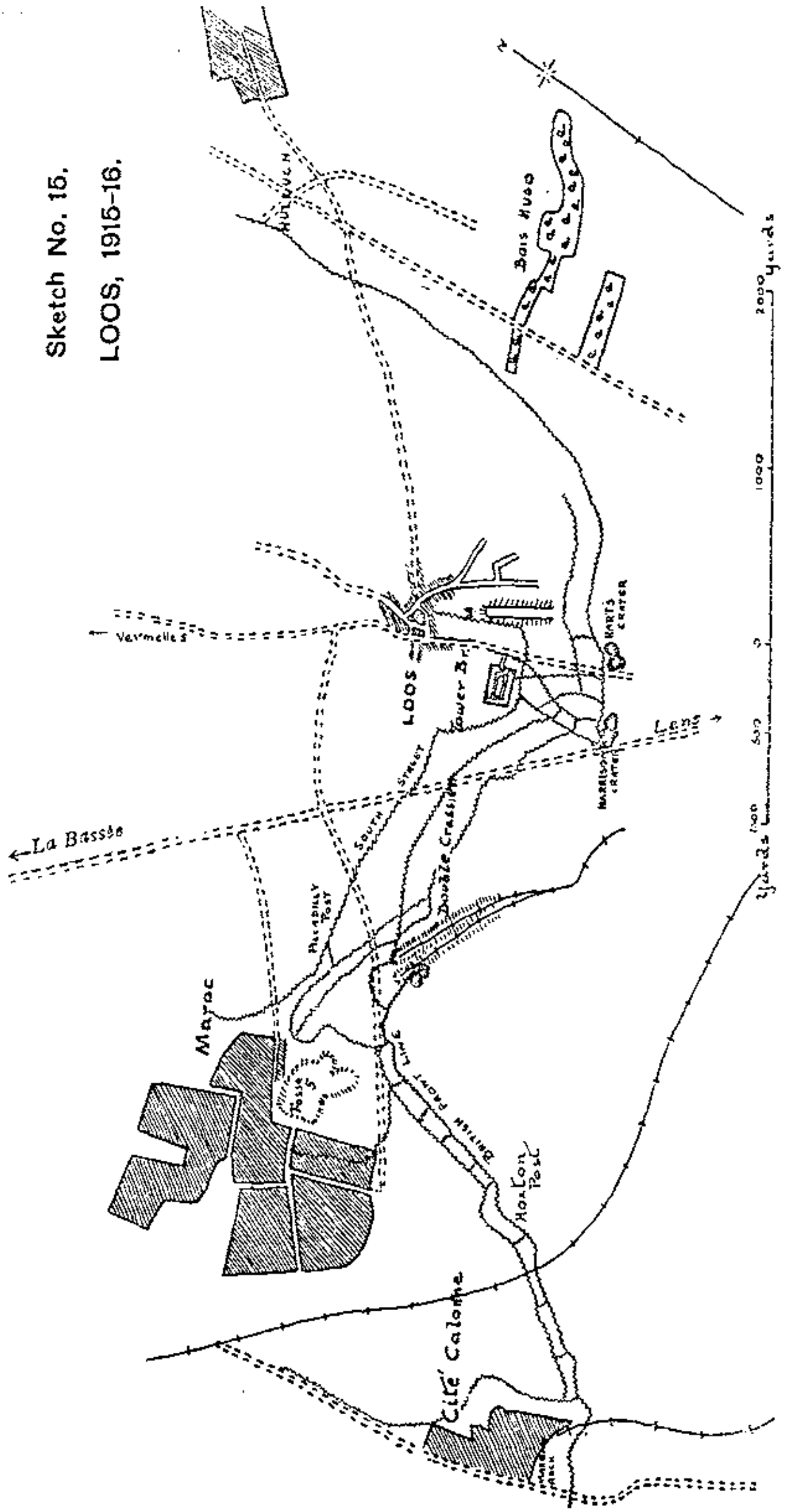
THE LOOS SECTOR.

AFTER the battle of Loos the 23rd (Field) Company withdrew from the line for a few days. Several changes took place amongst the officers; Lieut. Cohen joined on October 1st, and 2nd-Lieut. Vanstone on the 2nd (*vice* Mallins, wounded at Loos). On October 3rd, to the great regret of all ranks, " R.B.," who for nearly two years before the War had trained the Company to its high state of efficiency, and who had for fourteen months guided its destinies through the dangers and difficulties of the campaign with the affectionate loyalty of all those who served with him, at last handed over command of the unit on promotion to C.R.E. 1st Division. On the 8th October, 2nd-Lieut. W. H. Potterton joined.

Between the 5th and 13th October, the Company was again in the line near Hulluch, during which tour the Division carried out an abortive attack on Hulluch, in which Salmon was slightly wounded.

After this, a regular system of company reliefs was inaugurated, the 1st Division holding the Loos sector for many months. Field companies spent one month in Divisional reserve in turn, when the programme included hutting, drill, running, and so on, followed by two months in the forward area. Whilst in the forward area, each company had two sections living and working in the forward area and two sections available for work under the C.R.E.: collection of material, rear defences, road-making, and so on. The Company forward billets were mainly Philosophe and Les Brebis, the forward sections living in Calonne or Loos (Sketch 15).

Except for work at Hart's and Harrison's craters, described later, the winter of 1915–16 was comparatively quiet, work was organized on an almost peacetime basis, and a few typical jobs will suffice to give an idea of the sapper's life in a " peace " sector.



Sketch No. 15.
LOOS, 1915–16.

A bright thought on the part of " I " was to instal such a powerful telescope near the front that hostile shoulder-straps might be read and identification obtained without the blood and disturbance of a raid. A 15-foot telescope was installed in an abandoned trench north of the Corons de Maroc. Pivoted at the muzzle end, the eyepiece ran on a small rail and was supported on an eccentrically-pivoted grooved wheel, so that it could be set to fine angles of elevation. The observer, seated on a species of sliding-seat, shoved himself about with his feet, so that ex-" wet-bobs " felt thoroughly at home.

One of the first light railways was laid about this time. Starting in Les Brebis, it ran up the main broad-gauge to Maroc and thence across the open to join up with a German tramway leading into Loos near Fort Glatz. Affectionately known as the " midnight choo-choo," its chief merit was in the idea which produced it rather than its practical utility.

Machine-gun emplacements were made in considerable numbers. Amongst these were the " cart " and " second degree " emplacements. An old farm cart, on which the farm had fallen, was found sticking partly out from the debris. With its floor intact, it made a dark hole facing in the desired direction. A tunnel was dug from a cellar, coming up behind the cart, and a well-concealed emplacement was the result.

The " second degree " emplacement was in a raised road running to the German line from our front line at Calonne. A tunnel was cut along the road and a brick emplacement made flanking our wire. Unfortunately the occupants, incommoded by a thistle, got out by night and mowed a neat V in the grass, starting at the loophole. They were duly blown out next day. However, the 23rd (Field) Company, having given the enemy a day or two to pat himself on the back, built a new one, using the back wall of the old emplacement as the front of the new, the shadow thrown by the overhanging half-destroyed roof amply disguising the new loophole.

There was a certain " dud " 5·9″ shell which was inconveniently placed and looked on with grave suspicion by the infantry. It was therefore removed by the Company and placed, to add a bit more " pep," on a gun-cotton charge which was being used to blow down a wall. The wall came down, but the " dud " sailed away into the blue and fell still intact, and was then voted a complete dud.

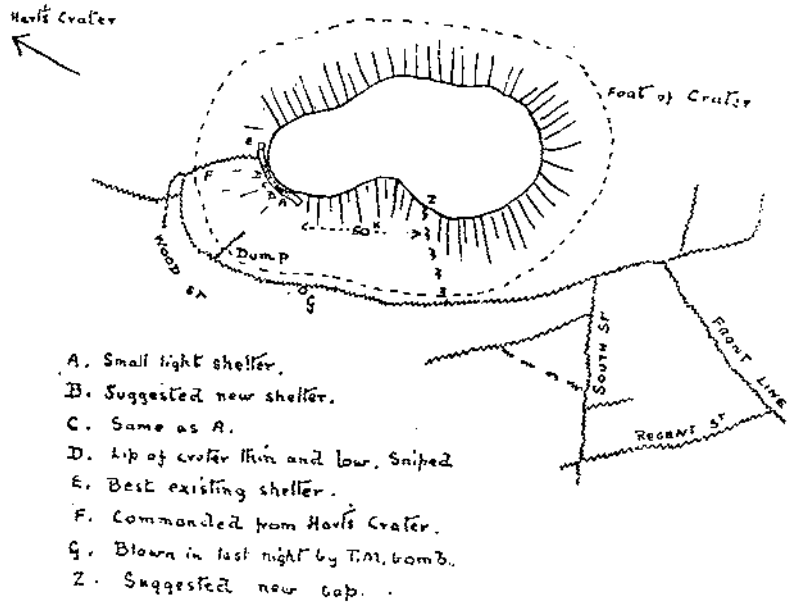
On 8th January, Captain P. J. Mackesy, R.E., joined for duty as O.C., and, four days later, Dawson left to become an instructor at Chatham.

A very important work during this time was the improvement of the Loos defences, in the course of which a difficult and dangerous job was the construction of strong bombers' shelters in Hart's and Harrison's craters, products of the mining operations which were now a feature of the War in this otherwise comparatively peaceful

sector. The work was so admirably carried out in the face of considerable difficulties that it is well worth describing in some detail.

The records available deal almost entirely with Harrison's crater (Sketch No. 16), but the conditions there were equally applicable to Hart's crater. These two, lying between the opposing front lines, were but a short distance apart. In each case the enemy held one lip and we held the other. The interest of both parties was maintained by a continual interchange of bombs, and as shelter was inadequate, the 23rd Company was called upon to provide bomb-proof shelters for the home team.

SKETCH No. 16.



Harrison's Crater.

(From report by O.C. No. 2 Section, March 8th, 1916.)

Light and rickety shelter was in existence, in which the bombers led a cramped and precarious life in the intervals of coming to the surface, heaving a bomb, and getting under cover again. Perched on the mound made by the debris of the huge crater, the performers were on an all too conspicuous stage.

Salmon (No. 2 Section) decided to utilize short R.S.J.s for roof and uprights, commencing with the worst shelter, B on the sketch. The first difficulty was the improvement of the approaches, for the communication sap, F, was open to the enemy's fire from Hart's crater, and movement up this unpleasant place to escape the snipers' attention was of the " tip and run " order. This was " no bon," as the soldier said, when carrying half a cwt. of R.S.J., and Salmon and

his men started a new approach from the other side. Some work had been begun here before, for in the mud of a shallow, battered trench were found the bodies of four men of the 26th Field Company. The enemy looked on this new development with little favour, and on successive nights made the work so unpleasant that it was found necessary to reduce the shifts from three hours to two hours to enable the sappers to bear the strain. Parties of two N.C.O.s and five sappers formed a shift. It was a thoroughly unpleasant corner; the men had to work up to their knees in a chalky, glutinous mud, ever and again waiting a moment in the meagre cover until the "whoo—oo—oo CRASH" and the subsequent pitter-patter of the falling mud and splinters had finished; then they would get going again, with perhaps part of the night's work to be done all over again. At the same time, constant watch had to be kept against crawling enemy bombers amongst the heaped-up debris of the crater. However, the approach sap was eventually completed and an infantry party of an officer and 20 men (nominally "resting" after a spell in the line) was provided to carry up the R.S.J.s. Unfortunately, at the critical moment when, stumbling and heaving along the muddy trench, they were about to dump their burdens at the foot of the crater, the enemy started to interfere, and it was not until next night that Salmon and his stalwarts were able to salve eight or twelve of the precious joists from the debris of the battered trench. Nevertheless the sappers stuck to their work with indomitable spirit, and in spite of constant shell-fire, sniping, and trench-mortar bombs, the work was completed.

Potterton, at Hart's crater, was faced with a similar situation, but having, after a week's hard work, completed his shelter, he had the heartbreaking experience of seeing it scattered by a T.M. bomb, and had to start again. The spirit in which the work was done cannot be better exemplified than in the words of the Divisional Commander:

To C.R.E. 1st Division.

I have noted with great pleasure the good work done by Nos. 1 and 2 Sections of the 23rd (Field) Company, R.E., on Hart's and Harrison's craters, and the soldierly spirit which induced these two sections to volunteer to continue the work rather than be relieved, so as to avoid the waste of time involved in carrying out such relief.

Special credit is due to the two officers commanding the above sections, viz., Lieuts. Potterton and Salmon.

A. HOLLAND, *Major-General,*
Comdg. 1st Division.

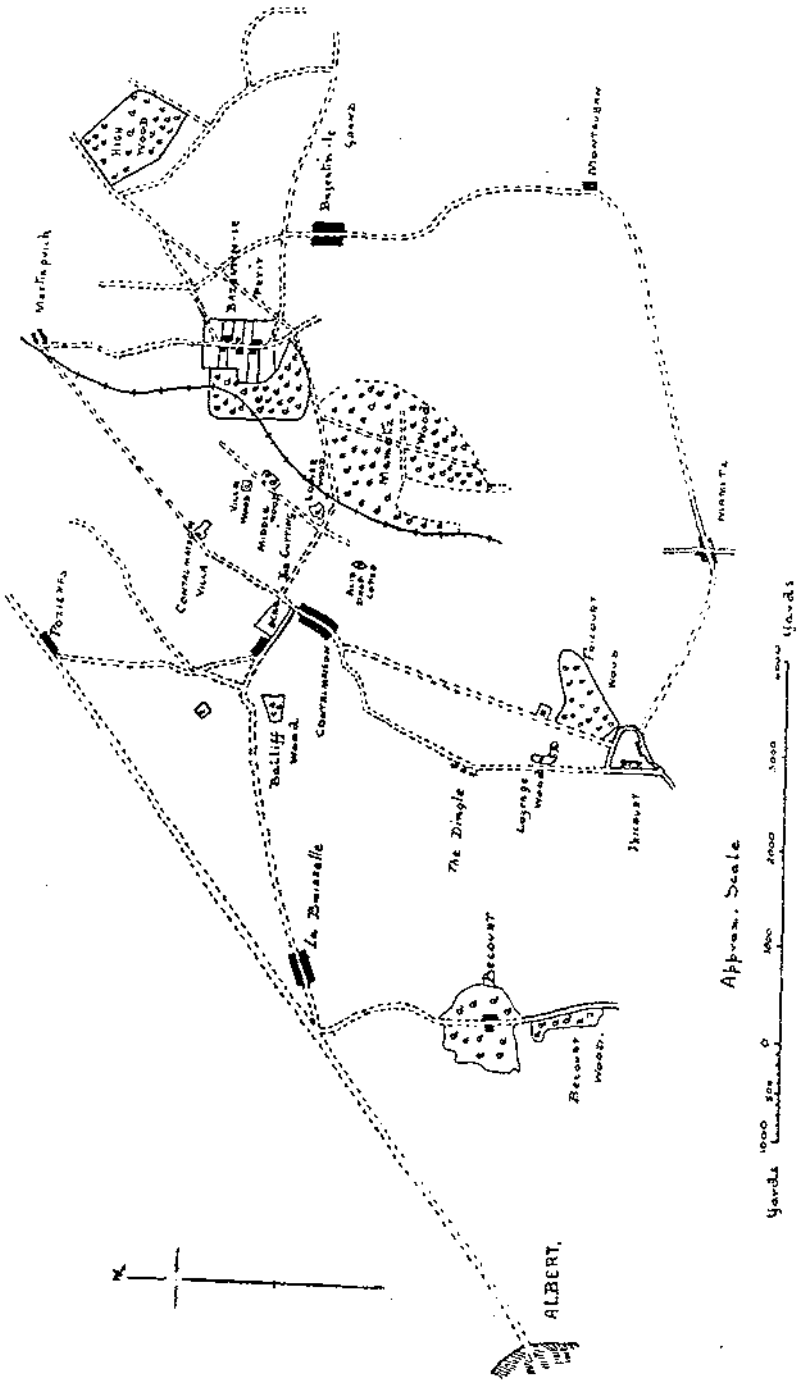
20.3.16.

At this time, a system was inaugurated of attaching infantry officers to the Field Companies for instructional purposes, so

Sketch No. 17.

THE SOMME.

1st Division Operations, 1916.



that these officers might return to their units trained in pioneer duties.

On 3rd June, 1916, Wilson, now promoted Captain as Second-in-command, was awarded the Military Cross, and C.S.M. Hudson, who had carried out his responsible duties in an admirable manner from the first days of the War, was awarded the D.C.M.

In Appendix D is shown a typical day's work extracted from the 23rd (Field) Company's progress report.

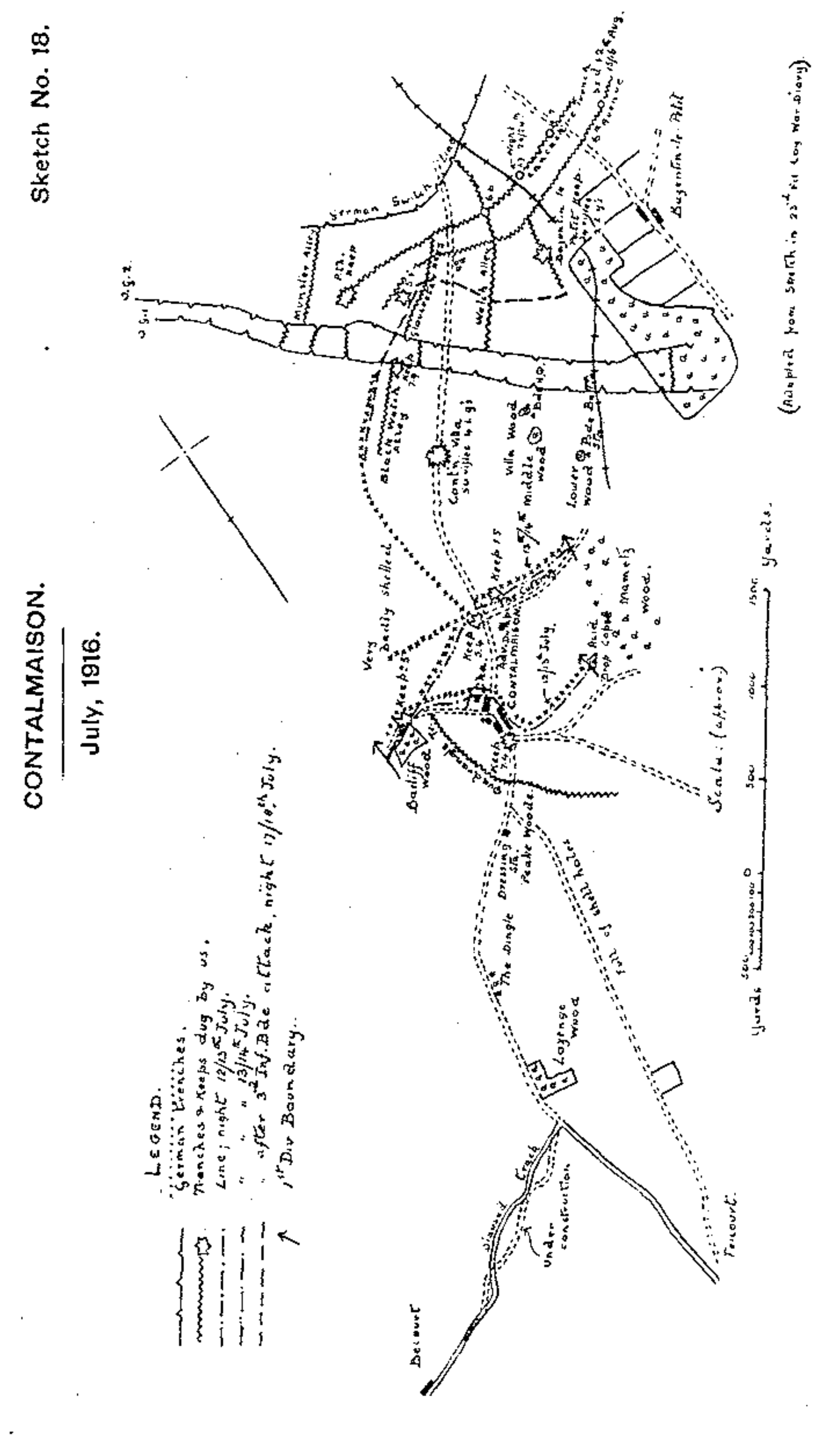
THE BATTLE OF THE SOMME (Sketches 17 and 18).

The Battle of the Somme commenced on July 1st, 1916, and it was not long before the 1st Division was drawn into the maelstrom, for on July 4th the Company moved at short notice to Ruitz, entrained at Fouquereuil at 2.15 a.m. on July 7th, and detrained at Doullens at 7.15 a.m. Marching on the 7th and following days by Warnies—Naours—Molliens aux Bois, the unit joined the 1st Infantry Brigade at Baisieux at 11.45 a.m. on the 9th. On the 12th, the increasing roar of hundreds of guns in action, swelling in a volume of sound beyond anything that the 23rd had yet experienced, formed the accompaniment to the march into Albert, where billets were taken over from the 228th (Field) Company (19th Division).

The 1st Division had just taken over the Contalmaison front after the attack in which the 23rd Division had captured that village. The 1st Infantry Brigade was established from the N.W. corner of Bailiff Wood through the château grounds and along the south-east side of the village nearly to Acid Drop Copse, where the Brigade was in touch with the 21st Division.

All four sections, under Captain Wilson, were ordered up to wire the front line and the keep at Contalmaison, where the 2nd and 3rd Infantry Brigades were taking over from the 1st. The front line at this time was as shown on the sketch. Contalmaison had crumbled into ruin under our bombardment, the road was practically obliterated. Immense holes, loose coils and shattered strands of barbed wire, piles of brick and rubble that had once been houses, uprooted trees, and all the mangled debris of the shell storm made unrecognizable the face of the landscape. But for the moment the artillery-fire had more or less died down, though on the move forward Salmon had a narrow escape. A shell bursting near him, a considerable lump of metal hit his saddle, where it was subsequently found driven right up the burr without having touched either himself or his horse, "Black Bess." Needless to say, his rude brother officers pointed out that this would not have been possible had his knee grip been all that one could wish.

The wire for this operation had to be "humped" from a dump somewhere about Lozenge Wood, and for this purpose the infantry


Sketch No. 18.
CONTALMAISON.
July, 1916.
LEGEND.
German trenches.
Trenches & Keeps dug by us.
1st Div Boundary.
German Switch
Munster Alley
Black Watch Alley
Welch Alley
Very badly shelled
Contn. Villa
Villa Wood
Middle Wood
Lower Wood
Bailiff Wood
CONTALMAISON
Mametz Wood
Peake Woods
The Dingle
Dressing Stn.
Full of shell holes
Lozenge Wood
Under construction
Fricourt
Becourt
Bazentin le Petit
Scale: (approx)
Yards
Yards.
(Adapted from Sketch in 23rd Fd. Coy War Diary)

were divided into parties of about a platoon, each with a sapper guide. The task of the guides in the tumbled battle area in the dark was no easy one, but as usual the initiative and resource of the sapper carried him through, and the large infantry parties, with the guidance and assistance of Wilson and his sections, wired the whole front strongly during the night. This was considerably helped by the fact that the enemy had, as a result of the fighting, withdrawn over the crest of the convex spur on which the village stood, and apparently was not sure of the position of our line.

On July 13th, the division pushed forward the line, establishing itself along the road from the north-west corner of Mametz Wood to the Cutting, and again that night the new line was wired, whilst the wiring of Contalmaison Keep was continued, Smith doing particularly fine work. The left half Company occupied uncomfortable bivouacs in Becourt Wood.

The destructive bombardments by massed guns were already bringing into prominence the difficulty of communication in the shelled areas, difficulties which, increasing during the winter, were to attain their apotheosis in the slough of Passchendaele. So that, in addition to the work on defences, a considerable portion of the Company was employed on the reconstruction of the road from Becourt to Lozenge Wood, hundreds of loads of brick from Fricourt being used.

On the night of the 16th–17th, the gallant Potterton, with some of his men, pushed out and successfully established two machine-guns ahead of our front line, in a work which eventually became Contalmaison Villa Keep. These guns were a great factor in the success of the attack of the following night, when the 3rd Infantry Brigade carried out a brilliant operation with no preliminary bombardment, capturing with small loss the German 1st and 2nd lines (O.G.1 and O.G.2), and establishing posts in communication trenches further forward; additional progress was made on the nights of the 19th, 20th and 21st, the 23rd Company continuing its work on forward roads and Contalmaison Villa Keep.

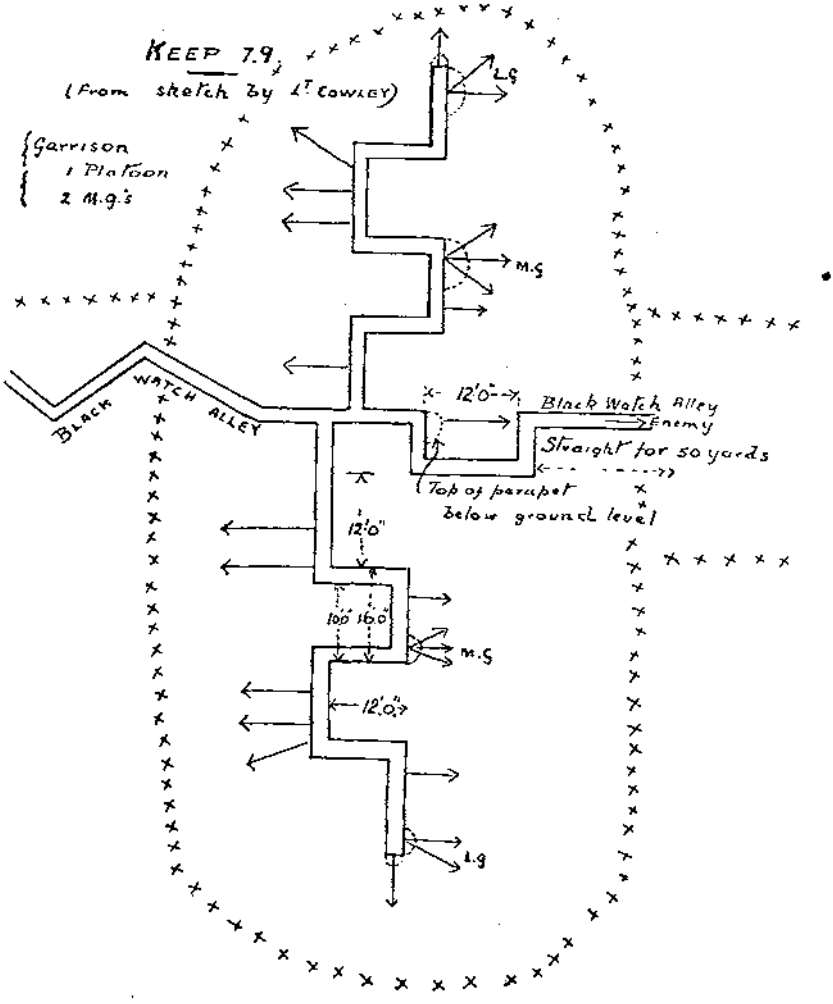
The 1st Division now side-stepped slightly to the right, the front extending from Bazentin-le-Petit to Black Watch Alley, in which a keep had been constructed typical of many in this area. As it shows the development from the circular bull's-eye type of 1915, a sketch of this keep is appended (No. 19).

An attack on the whole front by the 1st and 2nd Infantry Brigades was planned for July 23rd, and in preparation for this a battle station for Brigade H.Q. was constructed in Lower Wood, consisting of a cut-and-cover dug-out roofed with a cupola (as the "baby elephant" shelter was then called). Work on this dug-out was carried on in continuous reliefs.

On the night of the 22nd, Wilson, Edwards, Potterton, Vanstone

and Smith, with Nos. 1, 3 and 4 Sections, moved up into a position of readiness in Quadrangle Trench, anything but a salubrious residence. A somewhat prominent mark for the enemy's guns, it had received considerable attention; battered and worn and filled with debris, as one of the occupants has said, " nobody but a sapper would look

SKETCH No. 19.



at it "! However, it was made fairly habitable if not ideal, and there the sections awaited the opening of the bombardment, and spent a long and trying day under intermittent shell-fire, whilst the attack unfortunately made little progress.

At nightfall, the position was that we held the German support line and the enemy still held his switch line, both sides holding portions of communication trench between the two as saps. Under these

conditions the life of the sapper moving about in the dark between the lines was an exciting form of hide and seek. Scrambling round a large shell-hole it was quite easy to go only a quarter of the way round instead of half, and so start off in the wrong direction, whilst Very lights apparently going up in a complete circle gave no assistance as to the direction of the respective lines. It can be imagined, therefore, that when, after this attack, orders were issued for a new line to be dug by the 23rd (Field) Company and a large infantry working party, to cross the T of our communication trench posts between the opposing front lines, it was obvious to every sapper that the work was likely to be one of great delicacy. It was thought at headquarters that the new line was some 200 yards from the enemy's line, but unfortunately this was not the case ; it was subsequently ascertained that the true distance was 110 yards. The enemy in their saphead were closer still, and the working party had barely commenced its task when an unappreciated firework display began, the enemy's Very lights falling behind the infantry and sappers, who were thus silhouetted against the lighted background. Severe casualties were caused, including Potterton killed and Vanstone severely wounded. The former was actually engaged in his favourite amusement of establishing machine-guns in a forward shell-hole. In "Paddy" Potterton the Company lost a very gallant officer, who was quite fearless and had a high reputation for getting his job done whatever were the conditions.

In spite of this set-back, Division H.Q. gave instructions for another try to be made the following night, and in order to secure the digging party against interference Edwards was ordered to go out with two or three sappers and "fortify" a large shell-hole to the flank of the proposed trench, to act as a listening post. The little band, crawling through the long grass, eventually located the correct shell-hole, and had commenced to fortify it when the division next door started a small war, which at once woke up all the neighbours on both sides. Edwards and his worthies were about the M.P.I. of the opposing barrages, the usual sapper situation, so that there was little to choose between the two sides of the hole. When shortly before dawn the racket showed no signs of abating, Edwards decided that rather than spend a day in this open spot it would be better to make a dash for it. Squirming on their tummies through the grass for some distance, they got up and ran for it, and were lucky enough to get in without any harm. This is mentioned as typical of front line jobs in which the Company was continually employed at this time.

On the 26th July, the Company withdrew to Albert to rest, remaining out of the line until August 15th. On August 8th, Parkes, who had gone out with the Company in 1914 and had been wounded in 1915, rejoined ; the sections were now commanded by Edwards

(No. 1), Salmon (No. 2), Smith (No. 3) and Parkes (No. 4), Cohen being in charge of the transport.

On August 15th, the Company again moved into the forward area, with billets at Fricourt, the 1st Division having taken over a portion of line rather more to the right than before. That night an attempt by a large sapper and infantry working party to dig a new line between Bazentin and High Wood was only partially successful, severe shelling causing heavy casualties to both R.E. and infantry. An attack was planned for the 18th, in connection with which work in continuous reliefs was carried out in the construction of a Brigade H.Q. in Mametz Wood, again a "cut and cover" dug-out with "cupolas," with a bursting course of trees cut and carted from Bazentin-le-Petit Wood. This attack, however, made no progress, and the work of the Company subsequently consisted in the maintenance of tramways, water supply, road construction and so on about Mametz Wood. Work on roads in view of the battered nature of the area was of great importance, and necessitated much carting of timber and bricks, each section using as many as 40 wagons a day. One portion of road about Mametz Wood had been so heavily knocked about that Wilson decided to use slab timber for reconstruction. He was severely taken to task for his wasteful method, rather amusing when one recalls the miles of slab roads at Passchendaele the following year.

High Wood, September 3rd, 1916.

On August 27th and 28th, the 1st Division having now extended its right to take in High Wood, work in Bazentin-le-Grand was taken over from the 11th (Field) Company, 33rd Division, and work was commenced on Brigade H.Q. battle stations and the collection of tools and materials for special operations; as usual in these cases, work was by continuous reliefs, finishing on September 1st.

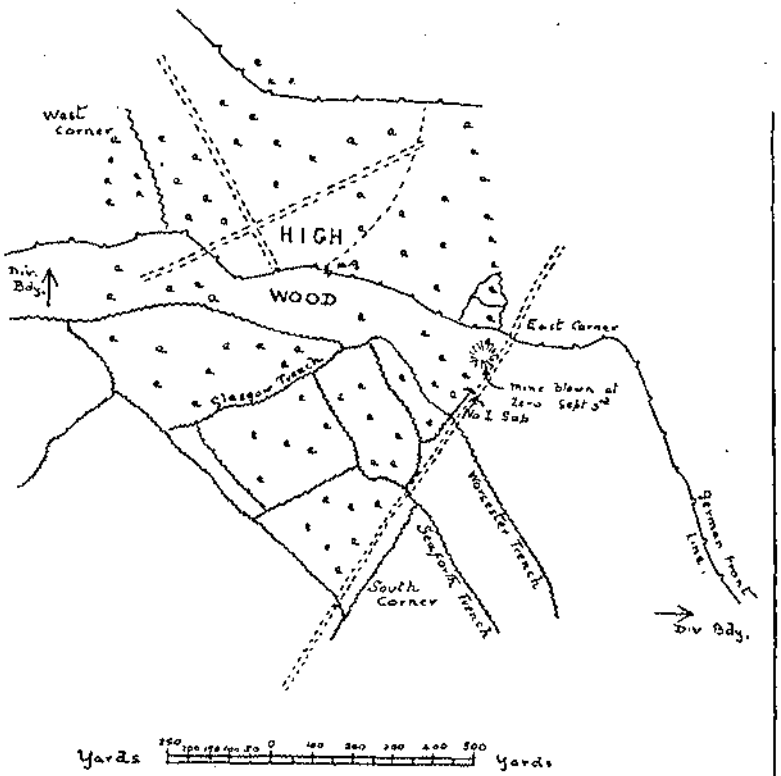
After a day or two in rest, the operation was carried out at High Wood on the 3rd September. The general plan was for the Black Watch to attack the German line east of High Wood and the Camerons to attack on the west. One officer and 40 men of the Black Watch, assisted by No. 1 Section, 23rd (Field) Company, to establish a machine-gun nest of four guns 50 yards beyond a mine crater to be blown at the south-east cover of High Wood (Sketch No. 20). No. 1 Section was to consolidate the crater.

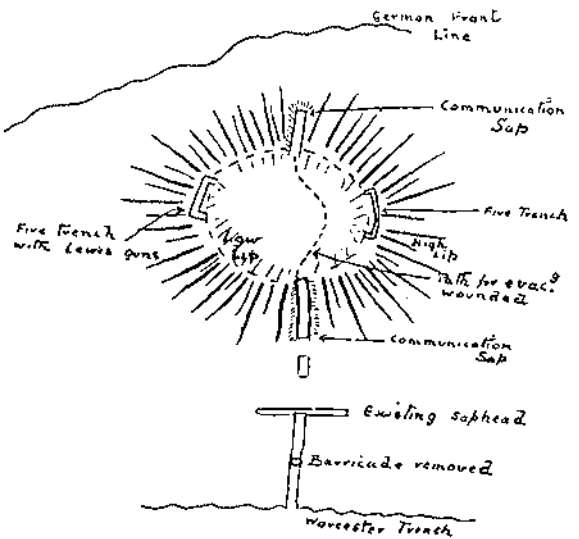
The mine was exploded at 12.0 noon, and the first sapper party, Cpl. Coles and four or five sappers, at once moved out after the assaulting infantry. Cpl. Coles and several sappers had been more or less seriously hurt by falling debris, as also had been some of Edwards' party waiting in the front line trench. Coles, however, got his small party digging at once, occupying the crater within five minutes of zero, but was almost immediately hit in the shoulder. This wound was bandaged, and he continued directing the work and

OPERATION AT HIGH WOOD.

Sketch No. 20.

September 3rd, 1916.





filling sandbags until shot in the jaw, which necessitated his withdrawal to the dressing station. Meanwhile, the work of consolidation was going on well. The Black Watch had captured a portion of the front line and were digging in their machine-guns 50 yards ahead of the crater, whilst Edwards and his section were hard at it running out a communication sap to join up with them and another behind to join up with a sap previously dug forward from our front line. Firing positions were being constructed on the right and left lips of the crater. Unfortunately the left lip being lower than the right, several casualties from machine-gun and rifle-fire coming from the left were caused to sappers working on the right.

About 3.30 p.m., the enemy were seen to be delivering a strong counter attack from half left across the front of the crater party, following the Camerons to the west. The infantry machine-gun nest had been knocked out, and the infantry who had manned the crater trenches were mostly killed or wounded. Edwards, therefore, collected the remains of his section and manned the crater lip, opening fire at short range on the massed enemy. Good practice was made for about 20 minutes, in fact Serjeant Mitchell, who had shown splendid energy in organizing the work and then the defence of the crater, was heard to say it was the best shooting he had ever had. Unhappily, this fine N.C.O. and Corporal Parker were both shot in the head and killed, and two sappers severely wounded. The latter could not be moved, and as Edwards was now running short of ammunition he ordered the remains of his section (only about eight men) to withdraw. The Black Watch in this part of the line had lost all their officers, and Edwards therefore collected such infantry as he could, and his own men, and getting a Lewis gun into action, continued the defence of the front line, inflicting heavy casualties on the enemy until the arrival of infantry reinforcements from the reserve companies. The losses of No. 1 Section amounted to 50% of the strength, but Edwards and his men had splendidly maintained the fighting record of the unit.

The following personal note was received from the 1st Brigade Commander in forwarding a special order complimenting the troops on their gallantry:

"Dear Wilson,

The enclosed order includes your people, and I take the opportunity to express my gratitude for the good work done by your Company, especially the crater party under Lieut. Edwards, and for his valuable information. The 23rd Company has always been most willing to help us in every way, and we couldn't have a better one.

Yours,

6.9.16. A. J. REDDIE."

For their gallant conduct on this occasion Lieut. Edwards received the Military Cross and Lce.-Cpl. Coles a bar to his Military Medal,

won but a few days earlier for conspicuous gallantry in rescuing a wounded officer.

On the following night, 3rd–4th September, all sections were employed in the repair of our front line trenches damaged by the enemy's defensive barrage.

Subsequent to this operation, the 1st Division and 47th Division relieved one another in the line from time to time, and several valuable advances were made and the line pushed northwards beyond Martinpuich and Flers. The 23rd Company worked as usual on forward defences and roads, dug-outs and salvage of material from old German trenches, on Corps line defences, dressing stations, and so on. It is interesting to note that for the first time in the Company diary mention is now made of a Corps line and army defences, the result of the lessons of defence in depth which the German resistance had shown to be so efficacious. The Corps defences for which the 23rd Company was responsible took the shape of a series of machine-gun nests, pairs of emplacements connected by slit trenches, and provided with dug-outs for the crews.

In the rear areas the main work consisted of roads and hutting, the latter being a very big work. The weather was abominable, and the mud increased daily, so that the strain on the horses, which were continually at work, was very serious, and in spite of unremitting effort on the part of Serjeant Ives, an invaluable mounted section serjeant, when the time came to leave the area the poor old hairies were sadly thin and out of condition.

In October and November, several changes in personnel took place. On 3rd October, Captain Mackesy was evacuated to England, sick, and Captain W. R. Wilson assumed command and was promoted to Major on 11th December; Cohen being promoted to Captain. Salmon (to Asst. Adjt., 1st D.E.) and Parkes (to 6th Pontoon Park) left, and 2nd-Lieuts. P. L. Forwood, Cowley and Gillespie joined, so that the sections were now commanded by Gillespie (No. 1), Cowley (No. 2), Smith (No. 3), and Forwood (No. 4). Cowley was a fine young officer, promoted from the regular ranks of the Corps, and quite fearless, as will be seen later in the story.

The Division remained in the High Wood area until January 25th, 1917. Before leaving, a beautiful cross made of oak from the ruined Bazentin church was constructed by the 23rd Company wheeler and carpenters, and was erected at High Wood in memory of the officers, N.C.O.s and men of the Division. In the summer of 1927, on the erection of the permanent memorial to the 1st Division near Etreux, the High Wood cross was brought home, and, after minor repairs, was re-erected by the 23rd (Field) Company outside 1st Division Headquarters, Aldershot, where, in the presence of representatives of the old Division, it was handed over by Sir Peter Strickland to the care of the G.O.C. 1st Division.

The seven months of ceaseless fighting and struggle against mud

and destruction had resulted in a casualty list for the Division exceeding 20,000, and the 23rd Company had borne its full share of the fighting and hardships, experiencing 42 battle casualties, representing practically 30 % of the effective strength of the four sections on whom fell the brunt of the losses. The Company had every reason to be proud of its record during these months. It was ere long to show that the mudlarking of the winter had not reduced its powers to execute rapidly and efficiently the more intricate technical jobs which, consequent on the German withdrawal, were to form a welcome change of employment.

APPENDIX D.

23RD (FIELD) COMPANY, R.E.

WORKS REPORT—Mid-day, May 29th, to mid-day, May 30th, 1916.

Calonne Sector.

1. Hoxton Road and Tamworth trench improvements continued; new traverses; revetting.
2. O.P. in York Street continued.
3. Revetting front line near Pit Prop Corner and building new fire bays.
4. O.H.C. to fire bays in Boyau 10.
5. Work on front line continued.
6. Work on reserve line continued.
7. Repairs to water pipe line.
8. Ampthill tunnel, ventilation shaft roofed.
9. M.G. emplacements Ousel's Post continued.
10. M.G.E. at end of Boyau 10 continued.
11. Gas blankets being fitted to cellars.
12. Ampthill tunnel driven 51 ft.
13. Dug-outs: (*a*) Tamworth Trench, right chamber started, left 3 ft.
    (*b*) Deviation Trench, right chamber started, left 2 ft. 6 in.
    (*c*) Hoxton Road No. 1, right chamber 2 ft. left 3 ft.
    Hoxton Road No. 4, right chamber 2 ft. left 4 ft.
14. Road tunnel Calonne Nord to Sud, 90 % complete.

Back Line Work.

1. Protection of Pump Fosse 11. Infantry party filling sandbags and sappers wattling.
2. Trench notice boards being painted.
3. Pipe lines being repaired.
4. Fixing taps to and repairing water tanks.
5. Cutting pit props, trench frames, etc.
6. Loading and carting stores.

(*To be continued*).

THE ARMOURED FORCE.

A Lecture delivered at the S.M.E., Chatham, on 1st November, 1928, *by* BRIGADIER R. J. COLLINS, C.M.G., D.S.O., *p.s.c., Brigade Commander, 7th Infantry Brigade.*

IN the limited time at the disposal of a lecturer, I propose to-night to deal only with one aspect of the many-sided problem which we have come to speak of as mechanization. I shall exclude all reference to that side which deals purely with the transportation of troops by mechanical transport, such as was developed to such a vast extent in the Great War—by the French, for example, during the German attacks on Verdun—and shall confine myself to the consideration of wholly mechanized forces capable of operating independently. Of these the present Experimental Armoured Force, which I have the honour to command, was last year the sole example. Now the American Army have also instituted something of a similar nature.

The knowledge of my audience varies probably from a fairly intimate acquaintance with the problem in all its aspects, theoretical as well as practical, to perhaps ignorance not only of the composition and organization of the Armoured Force as it exists to-day, but also of the types of armoured and other vehicles with which we are carrying out the experiment.

I am, therefore, in some difficulty as to how to approach my subject, but have finally decided that I may best hope to meet the wishes of the majority if I endeavour to summarize the result of some two years' experience, to take stock, in fact, of the situation as I see it to-day. You will then, I hope, be able to form your own conclusions. At any rate, those of you who are interested in the experiment—and no professional soldier can, I maintain, remain indifferent—will have a fairly sure jumping-off ground for further study.

I will endeavour to tell you what facts are, I believe, proved, what I personally have learnt, and the conclusions that I have come to.

1. Generally speaking, at the outset, I think it is right to say that armoured forces have shown themselves subject to the same "teething" troubles and limitations—relatively speaking—as normal formations. The human factor plays, in fact, as big a part as ever, and to attempt to ignore it will, as always, be likely only to lead to trouble.

2. I consider that we may fairly make the following claims for such armoured forces :—

(*a*) That they can function on their own over most types of continental country, but not in mountains, swamps, or forests.
(*b*) That their mobility is already at least double that of normal infantry formations, and is likely to increase yearly.
(*c*) That their power of endurance is far greater.
(*d*) That they have a great moral effect on such normal formations.
(*e*) That they can so limit the latter's freedom of movement as almost to render them immobile.
(*f*) That they are less vulnerable to air attack.
(*g*) That they are almost proof to persistent gas attack.

3. On the other hand, it is also only fair to say that practical experience has shown that they possess the following weaknesses or drawbacks :—

(*a*) They are very expensive in initial cost, though probably less than normal formations in annual upkeep.
(*b*) For their efficient functioning they demand such a high standard of training as to put them beyond the reach of any but a long-service professional army.
(*c*) Their mobility is limited, firstly by the present medium tank, and secondly by the problem of providing protection on the move, which latter is to some extent dependent on the degree and extent to which they can be armoured.
(*d*) They are peculiarly sensitive to ground, more so possibly than was thought until the recent practical tests.
(*e*) All the functions of the horse cannot yet be carried out as efficiently by machines.
(*f*) Their armouring presents a prodigious problem.
(*g*) Since the stationary gun will always have the advantage over the moving one, improvements in artillery and heavy machine-guns are likely to make attack by armoured fighting vehicles increasingly dangerous.
(*h*) Although they are generally economical in men, yet some infantry will always be a necessary part of their organization.

[The lecturer then discussed, with reference to lantern slides, the present state of design and the trend of developments in the case of armoured cars, light scout cars, light and medium tanks, half-track and six-wheel vehicles, self-propelled artillery and heavy machine-guns.]

4. In no walk in life is the attempt to peep into the future more fraught with danger than in the development of Armoured Forces. It is hard sometimes to realize in what an embryonic state these are to-day. But—in so far as our painfully inadequate experience can

be relied upon—the development along the following lines would appear advisable :—

(*a*) Armoured cars are tending to get so large, so heavy, and so expensive that they must be preceded in reconnaissance by some type of scout, to which the armoured cars will act more as a parent vehicle. For this new *rôle* the light car appears suitable.

(*b*) The medium tank is so wide, so cumbersome and so expensive, as well as so unreliable when called upon to cover long distances on macadam roads, that something cheaper and less cumbersome, even if less powerful, would appear necessary.

(*c*) For all-round simplicity, cheapness, reliability and mobility, six-wheel vehicles should be standard for all types except armoured fighting vehicles.

(*d*) In view of the danger to armoured forces from improvements in anti-tank defence, fast armoured close-support artillery and smoke producers must form a part of such forces.

5. The administrative questions connected with their handling are as numerous and as interesting as any of those so far mentioned. I have time only to touch on one, that of repair and salvage. In asking you to picture to yourselves what the mechanical counterpart of the R.A.V.C. should be, its organization and functions in peace and war, you will quickly get an idea of the immensity of the problem represented by mechanization.

6. Finally, I would urge caution on all those who are called upon to play a part in the development of mechanization. A balanced and considered opinion is not easy to come by. So much that appears in the Press, or even in military journals, is so obviously misinformed. For little reason that one can see, military opinion swings too quickly first to one side and then to the other. Personal predilections and idiosyncrasies, as well as a natural loyalty to the arm of the service in which one has been brought up, all play their part. The boasted " open mind " so often, I find, ignores the logic of facts, especially when these are unpalatable, and produces schemes of development and expansion which seem ludicrous to those of us who are in daily touch with practical realities. Hence, and in accordance with my General's wishes, I have steadfastly refused to indulge in any flights of fancy.

We are honestly and soberly trying out every link in the chain, basing our tests on what we know of war. This method will, I believe, provide the surest foundation for those to build on who come after us. Some may be present to-night. If so, I sincerely trust that they will be able to bear witness in after years that we laid the foundations well and truly.

STANDARDIZATION OF PERMANENT WAY.

By LIEUT.-COLONEL E. ST. G. KIRKE, D.S.O.

IN every branch of engineering the advantages of standardization are becoming increasingly recognized. A motor firm recently displaying all the components of their car in a shop window realized therefrom how many needless varieties of small parts such as bolts went into the car, and how great a saving could be made if they were all of one size.

The same thing has happened in the railway world. As a result of recent amalgamations of main lines in England, each system has found itself with a dozen different patterns of rails, fastenings, points and crossings, signals, etc. All these patterns worked very well, having no inherent defects, but it at once became obvious that the standardization of material on all the big English railways would make for cheapness in manufacture and all-round interchangeability.

A Permanent Way Standards Committee dealt with the problem, and as a result there is now throughout Great Britain one standard pattern of permanent way to which all railways are in process of conforming, as and when existing material falls due for renewal.

Although chaired track (*i.e.*, bull-headed rails on chaired sleepers) is practically universal in England, except for temporary or contractors' railways, in other parts of the world track is almost as exclusively formed of flat-footed rails resting on sleepers, with or without bearing plates in between, according to whether the sleepers are of soft or hard wood.

Flat-footed track is much lighter to transport and quicker to lay than chaired track (owing to bearing plates being much lighter than chairs), and it will inevitably be used on military railways.

So far there has been no attempt to standardize flat-footed track throughout the world, except in so far as the big consulting engineers may endeavour to do so on the various lines (in different countries) for whose designs they are responsible.

Standardization of track ensures that the rails shall be of standard length; that their dimension as to height of table and width of foot shall be identical; that the fish plates and bolts shall be of the same size; with holes at the same centres; that the bearing plates and dog spikes shall be the same; that there shall be a fixed number and spacing of sleepers in each rail length; and that every fitting or tool that can be dispensed with shall be eliminated, or unified with another from some other part of the track.

As regards the length of rail, this must be governed to a great extent by its portability, and therefore its weight per yard. For instance, a 100-lb. rail 60′ long weighs nearly a ton. Its handling by an ordinary platelaying gang of eight men without special appliances would be practically impossible.

It may be argued that a rail, once in the line, does not need handling, and this point is very sound in a country like England, where the railways have already been built, and transportation of rails consists of merely tipping them off wagons where they are wanted. In young countries, however, and on military lines, rails have to be carried by hand before they can be laid in the track. The limits of length sometimes accepted overseas are 45 feet for 80-lb. rails, and 36 feet for 100-lb. rails, each giving a rail weighing 1,200 lb. The length adopted by military, and some Indian railways, is 36 feet.

The height and depth of rails are so designed as to give the greatest strength for the least weight, and for this reason the old "square" dimensioned British Standard F.B. ("flat-bottom") rails, whose height and width of foot were the same, is now being replaced by the new B.S.F.B. rail, in which extra vertical stiffness is given by increasing the height while leaving the foot the same.

With regard to the fish plates, these must obviously be made to suit the rail section in all respects.

As to the fish bolts and nuts, it is clear that if every nut to be found on the permanent way, whether at the joints, heel-bolts of switches, check rail bolts, components of crossing, holding down bolts of bridge timbers, etc., are of the same size, one set of spanners will do for all of them. This reduces not only the number of spare parts, but also the tools which have to be provided. There seems no reason why every section of rail between 60 and 100 lb. should not have 1″ fish bolts, whether strength demands such large ones or not. The extra cost per mile of track would be negligible in view of the fact that if heavier rails were laid later on, as traffic developed, the same tools would still be used, instead of a fresh set having to be bought. It is, no doubt, this consideration which has led the Indian railways to use the same fish bolts for their 100-lb. and 75-lb. rails.

POINTS AND CROSSINGS.

In no part of permanent way can greater economy be effected than in points and crossings, for it is possible to select one, or at most two inclinations of crossing which will answer all ordinary purposes on any gauge. Indian railways (5′ 6″ gauge) have selected 1 in 12 crossings for their fast running, *i.e.*, passenger tracks, and the 1 in 8½ for goods yard work. In addition they use 1 in 10 crossings for passenger slips. South African railways (3′ 6″ gauge) find that all their work can be done on 1 in 9 crossings. In England practically

every number of crossing from a 1 in 1½ rising by half numbers to 1 in 20 are stocked and used. The reason for this is that lines have to be run into or alongside existing buildings, and crossover roads occur on curves, etc., whereas in young countries, *buildings are sited to suit railways, not railways to suit buildings.*

This should be equally true of military lines, and the designer of turnouts for military use will bear in mind that they may have to be laid by half-trained or untrained men; in gas masks; under fire, or bombing from the air; at night, when only occasional or even no lights may be allowed. Further, that when they are laid they may easily be destroyed, and the necessary material for replacement be hard to get at short notice.

A design of turnout for military railways (and it is for consideration whether civil lines would not also benefit from the same idea) should therefore ensure that

(*a*) Only one or at most two numbers of crossing should be used for all ordinary purposes.
(*b*) The whole turnout should fit into a definite number of rail lengths.
(*c*) No rail, or at most only one rail, should have to be cut to fit into the "lead" of the crossing.
(*d*) The divergence at the heel of switch should not be less than the width of the foot of the rail.
(*e*) The switch rails should be so planed that *any rail can be used as a stock rail*
(*f*) The same length of switch should be used on all turnouts, even if there were two or more numbers of crossing.
(*g*) The bearing plates riveted under the crossing should correspond with the standard spacing of sleepers.
(*h*) There should be a minimum of interference with the running road while the turnout is being laid.

(*a*) As regards the use of as few different numbers of crossings as possible, this has been touched upon above, and the advantages are self evident. On the 4′ 8½″ gauge a 1 in 10 (radius of curve 942 feet, *i.e.*, 2 gauge × number ^{2}) and a 1 in 7 (radius 461 feet) should meet all ordinary requirements.

(*b*) and (*c*). The importance of the whole turnout fitting into a definite number of rail lengths, and the avoidance of rail cutting, can be gauged by the experience of the B.E.F. in France, where the existing French turnouts seem to have governed our designs. Over ten thousand 1 in 8 crossings were laid by our railway troops, of the design shown in Fig. 1.

It will be seen that to fit the turnout into an existing track, two rails have to be cut to complete three whole rail lengths; that several rails have to be cut to fractions of an inch; that there is not a single

standard 36′ rail in the whole arrangement, and that, in short, there are no less than 12 rails of odd or special lengths.

Assuming that the 9-metre and 6-metre stock rails had to be used, Fig. 2 shows how the turnout could have been rearranged to eliminate all but four cut rails, namely, two to complete three whole rail lengths, and two for the closures to the crossing. All four " specials " can be cut from two standard 36′ rails. The slight increase of " lead " (or distance between the heel of the switch and the nose of the crossing) involved by this arrangement is of no practical importance.

When the time taken to measure up, cut, and re-drill rails is taken into consideration, plus the waste of material represented by rail ends, it is not too much to say that the design in Fig. 2 would have effected in France a saving, as compared with Fig. 1, of between a hundred thousand and a quarter of a million pounds.

For anyone who has a free hand to choose and design the crossings to be used on a military railway, the problem is to find the flattest crossing which will fit into 2, 3 or 4 rail lengths as the case may be, having regard to the nature and speed of the traffic, the rigid wheel base of the rolling stock, the curvature involved, and the gauge.

With 36′ rails, 72 feet are available in two rail lengths (plus expansion gaps which adjust themselves with other rails in the turnout, and do not need special consideration).

Of this 72 feet, 1 foot must be allowed between the end of the rail and the toe of the switch for the fish plates; then comes the length of switch, and, with flat-footed rails, this must not be less than about 15′, or the stock rail will always give trouble by bulging outwards. At the other end of the 72 feet, room must be left for the nose of the crossing, and for the fish plates of its rails to be put in without their nuts fouling each other. This distance increases with the flatness of the crossing, but is not less than five or six feet from the nose.

Of the 72 feet, some 22 feet are thus unavoidably taken up, leaving 50 feet for the " lead."

Each gauge has a factor by which to multiply the number of the crossing for the purpose of finding out the lead. On the 4′ 8½″ gauge the factor is 6·7, and it follows therefore that a 1 in 8 crossing cannot be fitted into two rail lengths unless the proper lead required (*i.e.*, 6·7 × 8 or 53·6 feet) is shortened.

If the lead is shortened, the sharpness of the curve is automatically increased until it is as sharp as the curve to a 1 in 7 crossing. This being the case, it is simpler to adapt the 1 in 7 crossing whose radius (461 feet) is no less than that of the 1 in 8 used in France.

Since 16′ is already earmarked for fish plates and switches, and a 36-feet rail is going to be used in the lead, it follows that the overall length of the crossing unit must be 72 less 52, *i.e.*, 20 feet, and the nose must be 11 feet from the end of the 36′ lead rail so as to give the proper lead of 47 feet. Fig. 3 shows a design embodying these

features, and it was found that a platelaying party, who had never seen the arrangement before, put in a turnout in about two-thirds of the time taken by a party who were familiar with the arrangement of the 1 in 8 used in France, the latter party taking 90 men-hours. With 45′ rails, a 1 in 8 can be very easily designed to fit into two rail lengths on the 4′ 8½″ gauge. There is plenty of room in 90 feet for a 1 in 8, and all that has to be done is to make the wing rails of the right length to add up with a standard rail to the proper lead: *i.e.*, the wing rail must be 53·6 less 45, making 8·6, say nine feet.

(*d*) Since no rails are to be cut, the nearest that the two rails at the heel of the switch can be put to each other is when their feet are touching. This means that the distance of their running edges apart, or "divergence," is the same as the width of the foot of the rail, and that the flangeway at the heel of the switch is the difference between the width of the top and bottom of the rail. With the 75 lb. B.S.F.B. rail (old or new pattern), this gives a flangeway of 2⅜″, which is ample to prevent an open switch acting as a check rail, unless wheel flanges are very worn.

(*e*) Planing the underside of the switch to ride over the flange of the stock rail is a most important point, and follows accepted practice in the North American continent, S. Africa, and elsewhere.

In effect it means that the switch can be applied at any point along any rail with no more work than drilling a few holes for the heel bolts and slide chairs, and that the stock rail retains its full strength. (In the form of stock and switch rail frequently met with on flat-footed track, the bottom flange of the stock rail is planed away, thus weakening it both vertically and horizontally. In the type in which the slide chairs are riveted to the stock rail, the rivets often get loose and ultimately break off, leaving the track unsafe until they are replaced.)

With the type of switch planed to over-ride the foot of the stock rail, repairs of a damaged turnout can be carried out much more quickly, since any rail can be taken from the siding, for the time being, to act as a stock rail, and only the switch blades and crossings have to be carried to site. This might mean the saving of much time, if motor transport were available to allow several places of a damaged line to be put in hand and repaired simultaneously. Another advantage of this type of switch is that it can be used during relaying work to avoid the cutting of closures.

(*f*) As stated above, a 15′ switch is the shortest which will avoid trouble caused by the stock rail bulging when flat-footed rails are used. It can be used for flatter crossings up to 1 in 10, and since switches are at best only a compromise, there seems to be no object in using any other length on military railways, where simplicity and uniformity are all-important.

In this connection it must be said that some designers attempt to lay the lead tangential to the *switch* with or without a short straight

through the crossing, instead of tangential to the *main line* and the crossing, which is the simpler way. The condemnation of the former lies in two facts,

(i) it sharpens the curve some 25 per cent., which is just what one wants to avoid, more especially since it serves no useful purpose.

(ii) the advocates of the second method have admittedly to use the first when the turnout leaves a curve, otherwise, to quote an American authority (Webb), "the main curve must be transformed into two curves on either side of the frog . . . but this will introduce a very great and needless complication, and is never done. The more simple solution is to consider that the frog rail is a chord of the original curve, which narrows the track gauge by an amount equal to the mid-ordinate of that chord . . . for all ordinary curvature this theoretical defect is not vitally objectionable or even appreciable."

(With a 1 in 10 crossing, for instance, if it is assumed that the curve continues through the crossing for four feet on each side of the nose, the track is just over 1-10th of an inch tight to the 4′ 8½″ gauge.)

On military lines, apart from the above objections, if simple turnouts can be put in without blue prints or calculations (and they are

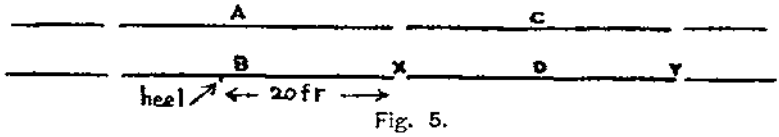


Fig. 5.

so put in on many first class railways even in peace), there is no virtue in confusing the platelayer by making an easy task seem difficult.

(*g*) The object of riveting the plates under the crossing at the same distance apart as the standard sleeper spacing is to ensure that, if a temporary turnout is wanted, or if crossing timbers are not available, none of the original sleepers need be displaced. If the crossing turnout is permanent, there is no difficulty about moving the original sleepers along to make room for crossing timbers. Fig. 4 shows a 1 in 10 crossing fitting into three 36-feet rail lengths. It will be noticed that in this case one rail is cut to form the closures. Both in this and the 1 in 7 the wing rails have been made the right length to simplify laying the turnout.

(*h*) There is no need to enlarge upon the importance of interfering with traffic as little as possible, and with "standard" crossings as described above the line need be broken for less than two minutes.

A short description of how a 1 in 7 "standard" crossing is laid into a running road may be of interest.

Supposing a turnout has to be put into the space occupied by rails "A," "B," "C," "D" (Fig. 5), with the crossing in "D." If rails drilled to take the slide chair bolts are available, it will pay to change them for rails "A" and "B."

The length of the crossing unit, *i.e.*, 20 feet, is measured from joint " X " in rail " B," and this is where the heel of the switch will come. The position of the holes for the heel bolts can then be marked off (with a fish plate as guide) and drilled. Fish bolts at " X " and " Y " are loosened, and spikes along rails " B " and " D " are partially drawn. Slide chairs are substituted for bearing plates where the switch is to come, and one or two half spiked to hold gauge. So far nothing has been done to interfere with the running of trains at reduced speed, except the substitution of drilled rails for " A " and " B."

When the line is blocked, joints " X " and " Y " are broken, end " X " of rail " B " is swung open, rail " D " is pulled down 20 feet, and the crossing unit " Z " put in after the bearing plates on the sleepers concerned are removed. Both ends of the crossing are fished up, and the switch " S " after being fished up to end " X " of rail " D " is spiked home against rail " B " (Fig. 6).

A few spikes are driven home along rail " D " and on the crossing. The track is then once more ready for through running, on the

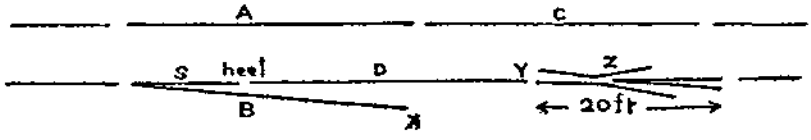


Fig. 6.

original sleepers, which have in no way been unpacked. The above placing of the crossing can be done in less than two minutes.

The remainder of the work can then be proceeded with at leisure, consisting in completion of spiking the through road; sandwiching in sleepers for turnout; drilling rail " A " for heel of other switch, and fitting slide chairs, drilling rail " C " for check rail (which rests on the original bearing plates); crowing and fixing lead rail; fixing stretcher rods, pull rod and lever, after scarfing extensions on to the two sleepers at toe of switch; fixing other check rail, etc.

Throughout the operation, rails " A " and " C " remain unbroken except in so far as drilled rails may be substituted for them. Even so, it will often be found best to leave the drilling of the holes for heel bolts to be done at site.

It is not suggested that these standard crossings will meet all the exigencies of a military railway, but under ordinary conditions they will suit 95% of the turnouts required, and as such are well worthy of adoption.

From the above it will be seen that, by making its wing rails the right length, there can be designed for any rail length on any gauge one or more crossings which can be fitted into a definite number of rail lengths, without involving the cutting of more than one rail at

most for the lead. Further, such crossings can be selected, as regards inclination and curve lead radius, to suit all the requirements of traffic and wheel base. Since such is the case, it seems to be not only a waste of money to use any crossings which do not fulfil these conditions, but also a needless waste of time when the laying out of stores yards and depot sidings (matters of serious consequences in the conduct of a campaign) is involved.

Lest it be thought that there is any difficulty about manufacturing the above, it may be said that both with 100-lb. rails 45 feet long, and with 75-lb. rails 36 feet long, half a dozen firms in England have tendered for switch blades, points and crossings on the above design without question.

Many lines have a custom of using coach screws for holding down bearing plates and slide chairs through a turnout, thus necessitating a special set of box spanners which are all extra to carry about. If, however, such bearing plates and slide chairs are made with four holes for dogspikes, these will be found quite satisfactory, and special spanners for coach screws can be done away with.

CURVES.

It is sometimes thought necessary to have rails of special lengths, *e.g.*, 35′ 6″, 33′, 30′, etc., for curves, their ends being painted different colours. This is, however, not the case if joints are staggered round curves, as they generally are, except on English railways, whose curves are in most cases very easy, and the track much heavier than F.F. track.

If the length of the curve is known, all that has to be done is to cut one rail into two parts, whose difference in length is the same as the difference in length of the inner and outer rail round the curve. The stagger can then be given by putting the shorter length on the inner rail at the beginning of the curve, ending up with the longer portion on the outer rail.

The difference in length of the inner and outer rail round a curve is given by the formula

$$\text{Difference} = \frac{\text{Length of curve} \times \text{gauge}}{\text{radius.}}$$

If, for instance, the inner rail is found by this formula to be four feet shorter than the outer, one 36′ rail can be cut into one 16′ and one 20′ length.

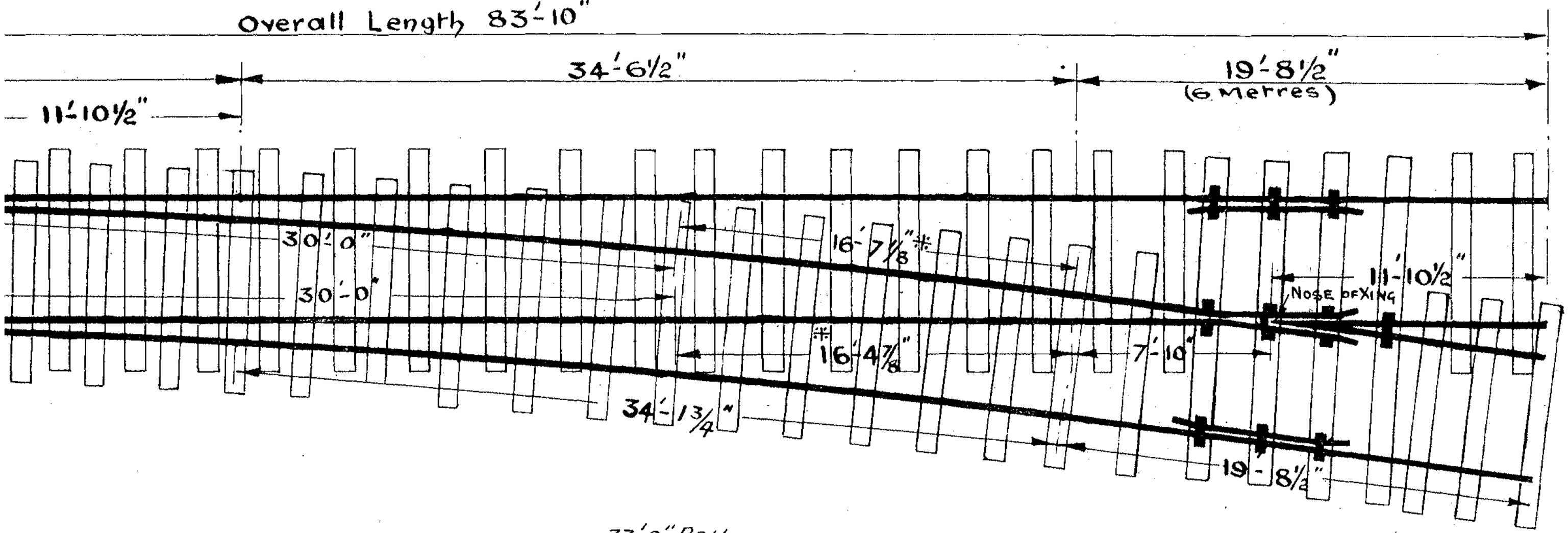
The use of standard rail lengths in crossings has been dealt with above, so the need for special rails disappears, thus simplifying stacking in storeyards by cutting out the need for sorting. In the few cases where rails may have to be cut to keep their joints away from the centre of a bridge girder, this can be done on the spot.

FIG. 1.

JRNOUT (WITH STOCK RAILS)

AS USED IN FRANCE

CALCULATED LEAD = 54'-4 1/8"
ADOPTED " = 54'-2 7/8"
RADIUS OF CURVE = 463'



* CUT FROM A 33'-0" RAIL

1 IN 8 TURNOUT (4'-8½" GAUGE)

DESIGNED TO SUIT TYPE CROSSING AS USED IN FRANCE (Fig.1.)

CALCULATED LEAD = 6·7×N = 53·6'

LEAD ADOPTED - 55'-5" (TO AVOID CUTTING 36'-0" RAILS)

RADIUS OF CURVE = 603'

SCALE - $\frac{1}{4}$" = 1 FOOT

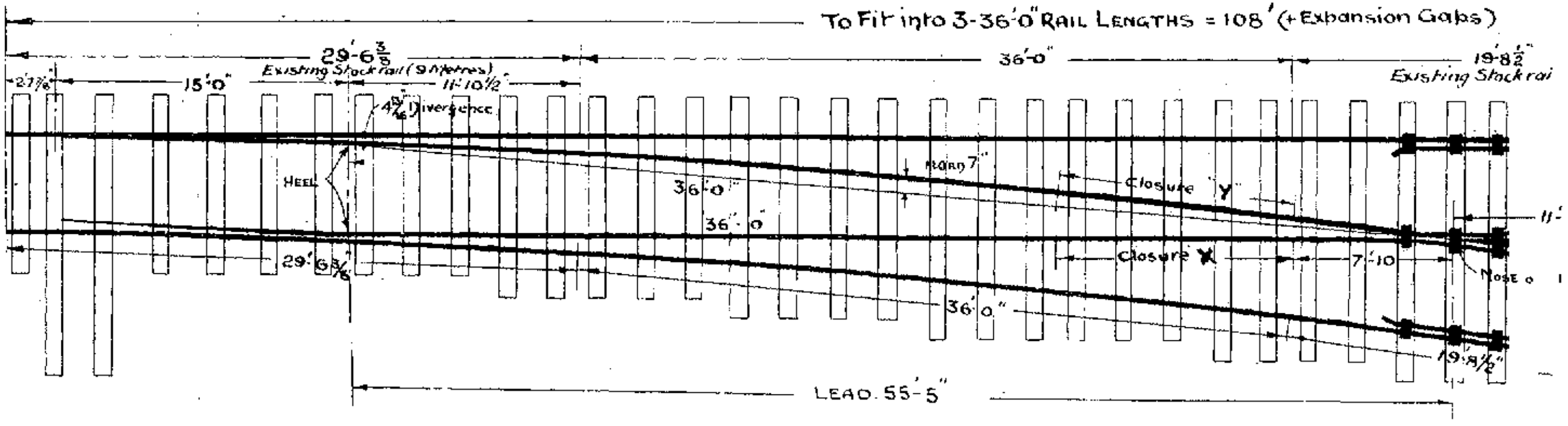


Fig.3

1 in 7 TURNOUT (4'-8½" GAUGE.)

SCALE - ¼" = 1 FOOT.

TO FIT INTO 2-36'0" RAIL LENGTHS.

BUILT UP OF 8'6" SLEEPERS IN LIEU OF CROSSING TIMBERS

Gauge: 4'-8½"
Curve Lead - 2GxN = 65·9'
Radius of Curve = 2GxN² = 461'
Lead (Heel of Switch to Nose of Xing) = 6·7N = 47' (approx.)

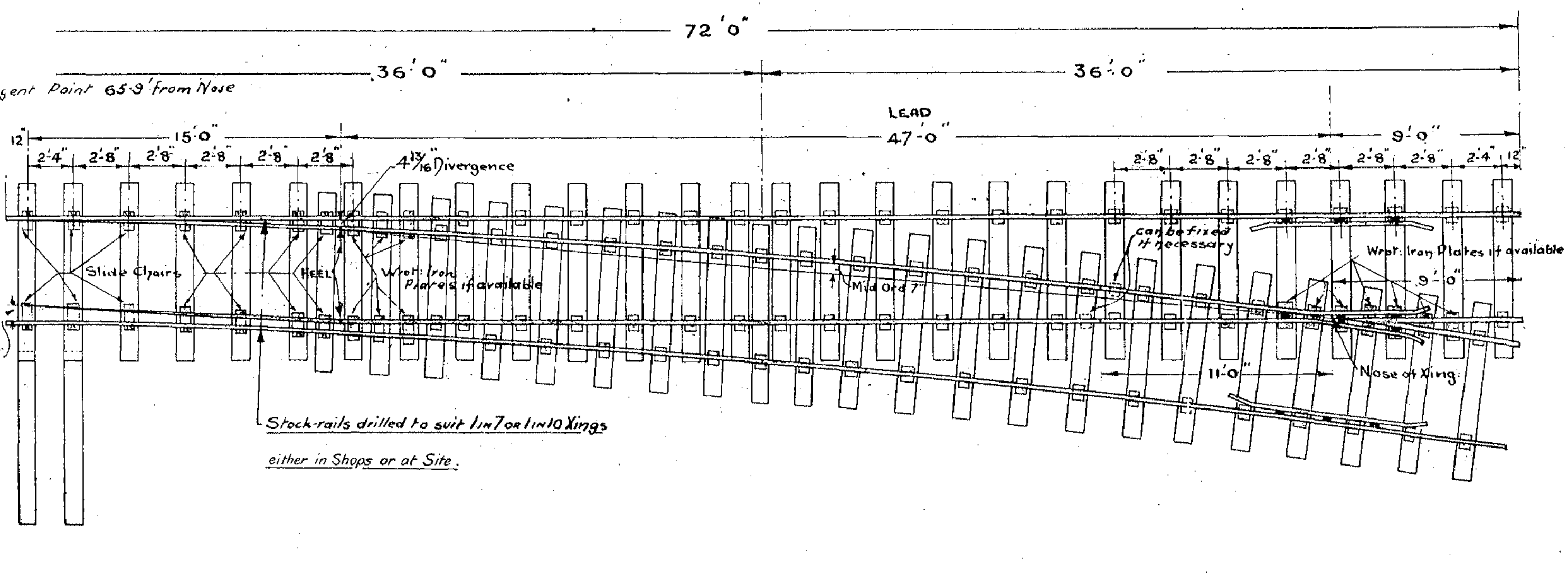


FIG. 4.

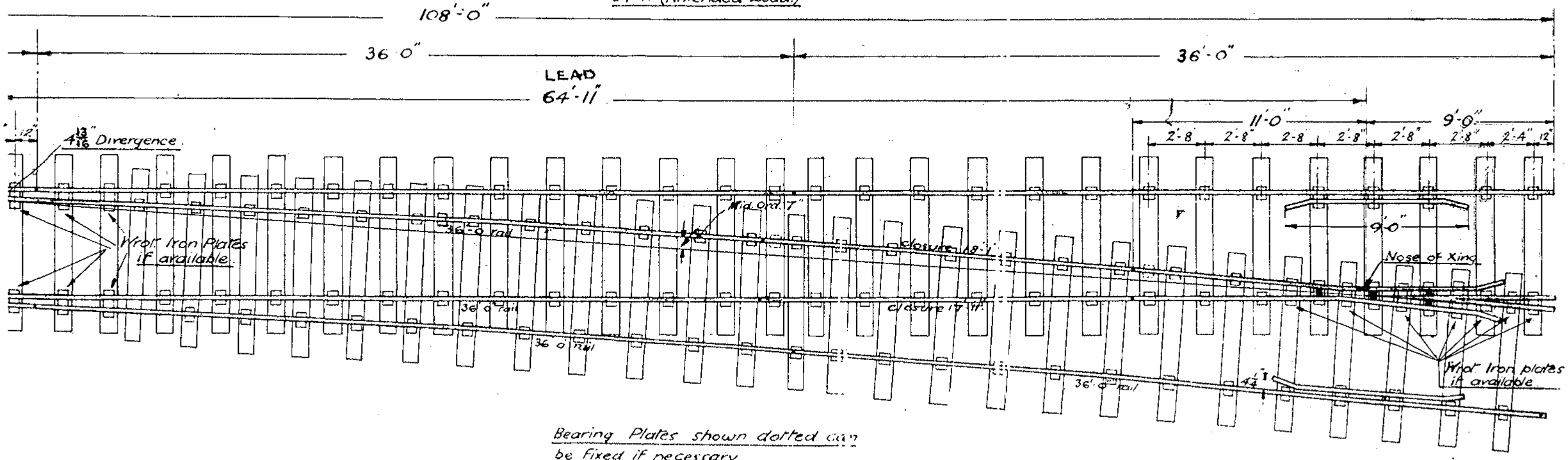
1 IN 10 TURNOUT (4'-8½" GAUGE.)

SCALE - ¼ = 1 FOOT.

TO FIT INTO 3 - 36'-0" RAIL LENGTHS.

BUILT UP OF 8'-6" SLEEPERS IN LIEU OF CROSSING TIMBERS.

Gauge = 4'-8½"
Curve Lead = 2GxN = 94.2'
Radius of Curve = 2GxN² = 942'
Lead (Heel of Switch to Nose of Xing) = 6.7N = 67'-0" (Calculated Lead.)
64'-11" (Amended Lead.)



Bearing Plates shown dotted can be fixed if necessary

PALESTINE.

A Lecture delivered at the S.M.E., Chatham, on December 6th, 1928, *by* FIELD-MARSHAL THE VISCOUNT ALLENBY, G.C.B., G.C.M.G., D.C.L., LL.D.

TOPOGRAPHY AND HISTORY.

PALESTINE and Syria form, geographically, one country; lying between the Mediterranean Sea and the Arabian Desert. It is a tract of land 70 to 100 miles in width, and about 500 miles in length; bounded on the north by the Taurus Mountains, and on the south by the Desert of Sinai.

Parallel to the coast, southwards from the Taurus, are two mountain ranges; with, between them, a deep valley—the Lebanons and their valley—forming Syria. These mountains rise, snow-capped and well watered, the western range to a height of 7,000 feet and the eastern—Mount Hermon—to a height of 9,000 feet.

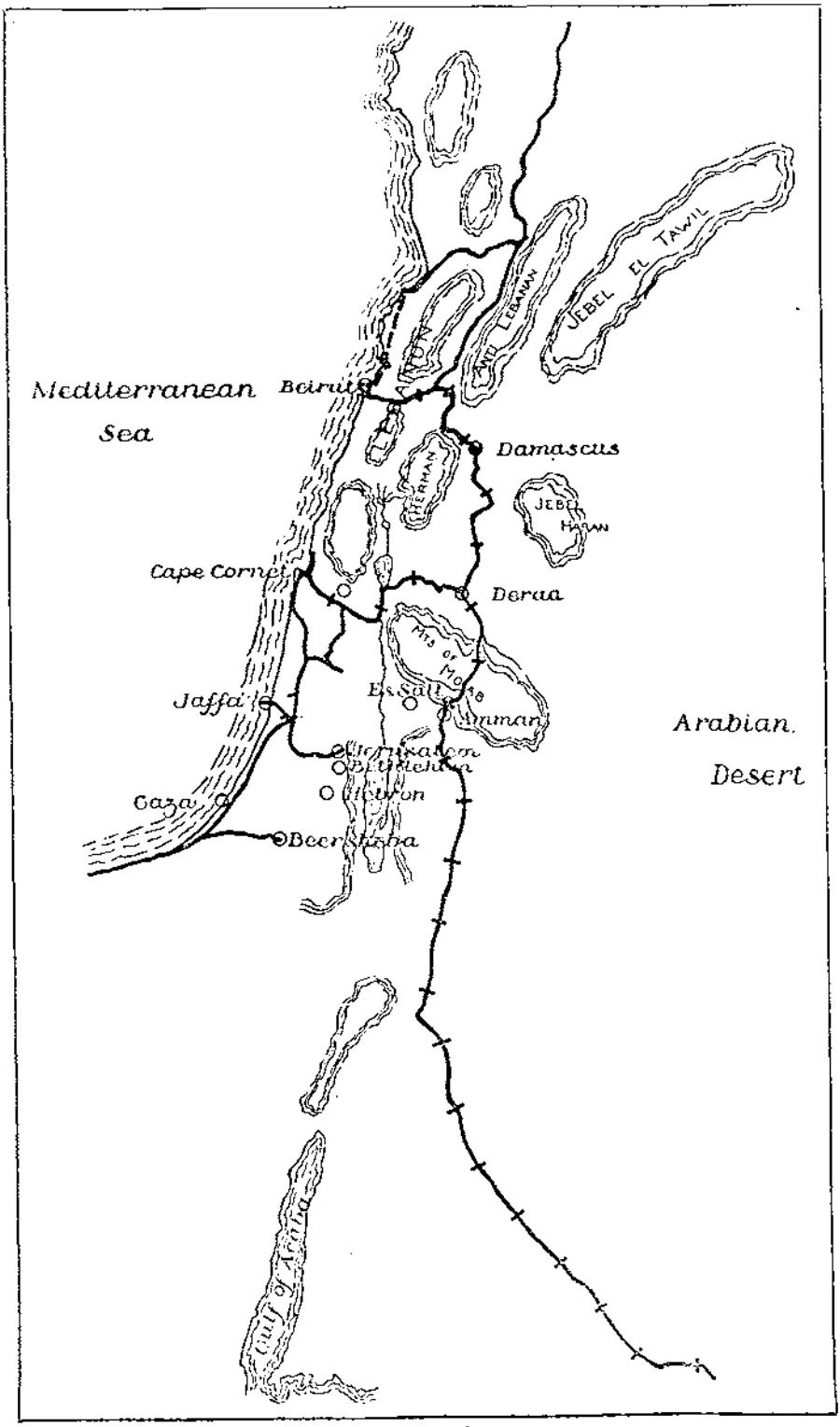
South of the Lebanons, the valley sinks rapidly, nursing the River Jordan, through Lake Huleh, to Lake Tiberias (Galilee) which is some 700 feet below the level of the Mediterranean. Sixty-five miles further south is the Dead Sea—1,300 feet below sea level. The length of the River Jordan, from its source in the Lebanon to its mouth in the Dead Sea, is roughly 130 miles. Its valley, a volcanic rift, is the deepest depression in the earth's surface.

The western range of Lebanon runs in a southerly direction; is broken by the Valley of Esdraelon; rises again, and throws out a branch to Carmel on the coast; then, continuing southwards, it forms the mountains of Judea—on which stand Jerusalem and Hebron. South of Hebron, the range sinks to Beer Sheba on the rim of the Desert.

The eastern range, on the left side of Jordan, forms the Hauran and the plateau of Gilead and Moab—the present Trans-Jordania; beyond is the Arabian Desert.

The western range constitutes the centre, or backbone, of Palestine. A rugged ridge of limestone, it rises, at Jerusalem, to about 2,700 feet—at Hebron, to 3,000 feet above sea level. Westwards, it falls gradually to the plain; its eastern face drops precipitously to the Jordan Valley and the Dead Sea.

Thus Palestine, including Trans-Jordania, is divided into four long strips; the Maritime Plain, the Judean Mountains, the Jordan Valley, the Eastern Range.


Mediterranean Sea
Beirut
Damascus
Cape Carmel
Jaffa
Gaza
Beersheba
Jerusalem
Hebron
Es Salt
Amman
Arabian Desert
Gulf of Aqaba
JEBEL EL TAWIL
ANTI LEBANON
JEBEL HAURAN

General Map.

A section taken from Jaffa, through Jerusalem, to Mount Nebo in Moab, shows a rise from sea level at Jaffa, to 2,600 feet above the level of the sea at Jerusalem ; a fall to 1,300 feet below sea level at the Dead Sea ; then, a rise to 2,700 feet above ; in a distance, west to east, of 70 miles.

The ancient high road between Africa and Asia lies along the Maritime Plain, the trade route and battle path of rival civilizations for thousands of years.

Carmel is united to the main range by a ridge which is pierced by the pass of Megiddo—also known as Musmus, or Lejjun. There is also a pass between Carmel and the seashore. Northwards, across the fertile plain of Esdraelon, the road runs, on either side of Lake Tiberias, to Damascus, Aleppo, and the broad lands drained by the Euphrates.

This way came the Hittites, from Asia Minor ; this way marched the victorious Ethiopians, after their conquest of Egypt (see II Chron., xiv, 9). Assyrians, Egyptians, Persians, Greeks, Romans, all have fought and traded on that well-beaten track.

By this road, too, came the Plague, travelling with the armies from the Delta swamps and the dread Serbonian bog on the Egyptian frontier. It decimated many armies, from Sennacherib to Napoleon Bonaparte.

The early dwellers on the coastal plain, the Canaanites, were driven out or absorbed by the Philistines who arrived from Crete, probably, at about the time when the Israelites left Egypt. The children of Israel were not able to fight their way through the fierce tribes of Palestine's Desert boundary ; they passed south and east of the Dead Sea, and made their entry by crossing the Jordan, near Jericho, establishing themselves in the high hills. Thenceforward, though masters of the mountains, they never got a permanent footing on the plains. Amid their hills they held their own, in the low ground the Philistines usually prevailed.

Jerusalem's importance lies in its position on the plateau, at the junction of the roads and passes. Southwards, from Jerusalem, along the crest of the ridge, is the road to Beer Sheba. Northwards, it runs by Bethel to Nablous, and onwards to Esdraelon. Several passes communicate with the coastal plain. The Wadi Sunt to the south-west is the old Vale of Elah—scene of many a conflict with the Philistines—which led to their city of Gath. The reputed site of Gath is the limestone bluff at the entrance to the Pass, Tell es Safi, called by the Crusaders Blanche Garde. North of this is the Vale of Sorek, or Wadi Surah, through which runs the railway. Further north, by Bab el Wad and Khuryet el Enab, the modern road leads to Jerusalem. Next, we find the Vale of Ajalon, or Yalu ; and, north of this, Bethoron the Upper and the Lower—Beit Ur el Foka and Beit Ur el Tahta. Eastwards, roads cross the Jordan Valley,

connecting Jerusalem with Jericho, and with Es Salt and Amman, giving access to the cornlands of Gilead; and leading, through Edom, to the Gulf of Akaba and the Red Sea.

All these roads converge at or near to Jerusalem, giving facilities for travel and commerce in all directions: hence the great prosperity of the city under the Warrior King David and Solomon, his son.

Projecting from the western foothills is a remarkable feature; a hill, rising to a height of 700 feet—Gezer, or Abu Shusheh—the Mont Gisart of the Crusaders, beside the road to Jaffa. High, rocky, yet fertile in soil, and with abundant springs of water, it guards the passes from Jerusalem, as they open on the plain. When Solomon came to the throne, Gezer was a Canaanite fortress. It was taken by Pharaoh of Egypt, who destroyed the town and killed its inhabitants. Solomon took Pharaoh's daughter to wife, and obtained Gezer as her dowry. The possession of this stronghold assured access to, and control of the Plain, the great High Road; an asset which the business capacity and diplomatic wisdom of Solomon enabled him to use to his great advantage.

THE CAMPAIGN IN PALESTINE, 1917–18.

The original idea in keeping a force in Egypt was to guard our communications with the East. General Murray's advance to the Palestine border, in 1916–17, was the surest way of protecting the Suez Canal. Later, the threat to Mesopotamia by the so-called Yilderim Army of Von Falkenhayn, from Aleppo, led to our counter-stroke at his flank through Palestine.

I assumed command of the Egyptian Expeditionary Force in June, 1917.

During that summer, the Force lay on a front of twenty-two miles from the sea coast, near Gaza, to Gamli, facing the Turkish Army which held a position, from Gaza to Beer Sheba, thirty miles long.

Our army was occupied in refitting and reorganizing. It consisted, by the end of the summer, of the Desert Mounted Corps of three Divisions, under General Sir Harry Chauvel, and seven Divisions of Infantry. The seven Divisions were organized in two Army Corps, the XX. under General Sir Philip Chetwode, and the XXI. under General Sir Edward Bulfin. In addition, there were some attached units, including a small French contingent and a small Italian contingent.

My plan was to assume the offensive as soon as our preparations were complete, and to capture Beer Sheba, thus turning the enemy's left.

To distract the enemy's attention, it was also decided to attack Gaza, and a scheme for this was prepared by General Sir E. Bulfin, in co-operation with the Navy.

The operation against the Turkish Left was assigned to Sir Philip

Chetwode, commanding the XX. Corps. His main difficulties were transport and water, as his task involved a long desert march. Practically the whole transport, including 30,000 camels, had to be allotted to him for carrying food and ammunition, and preparations were put in hand for a railway, to be pushed rapidly towards Beer Sheba.

The line of approach was under view of the Turkish positions, and secrecy of preparation was a difficult matter.

A bombardment of the Gaza lines began on the 27th October; and, after a long night march, Beer Sheba was attacked on the morning of the 31st, from the south and east. By nightfall, Beer Sheba was in our hands. This victory laid open the Turkish left.

Gaza was attacked on the 1st November, and good progress was made on that and subsequent days.

During the consolidation of our positions round Beer Sheba, fighting was bitter and continuous; till, on the 6th November, the Turkish line succumbed to a renewed attack and was rolled back in confusion.

Gaza fell on the 7th, and the Turkish armies retreated, mostly northwards along the plain, and a few by the mountain road towards Hebron.

All of our troops for whom transport was available—three Mounted Divisions and two Infantry Divisions—were launched in pursuit along the Plain, and another Division, the 53rd, followed those of the enemy who had chosen the road to Hebron.

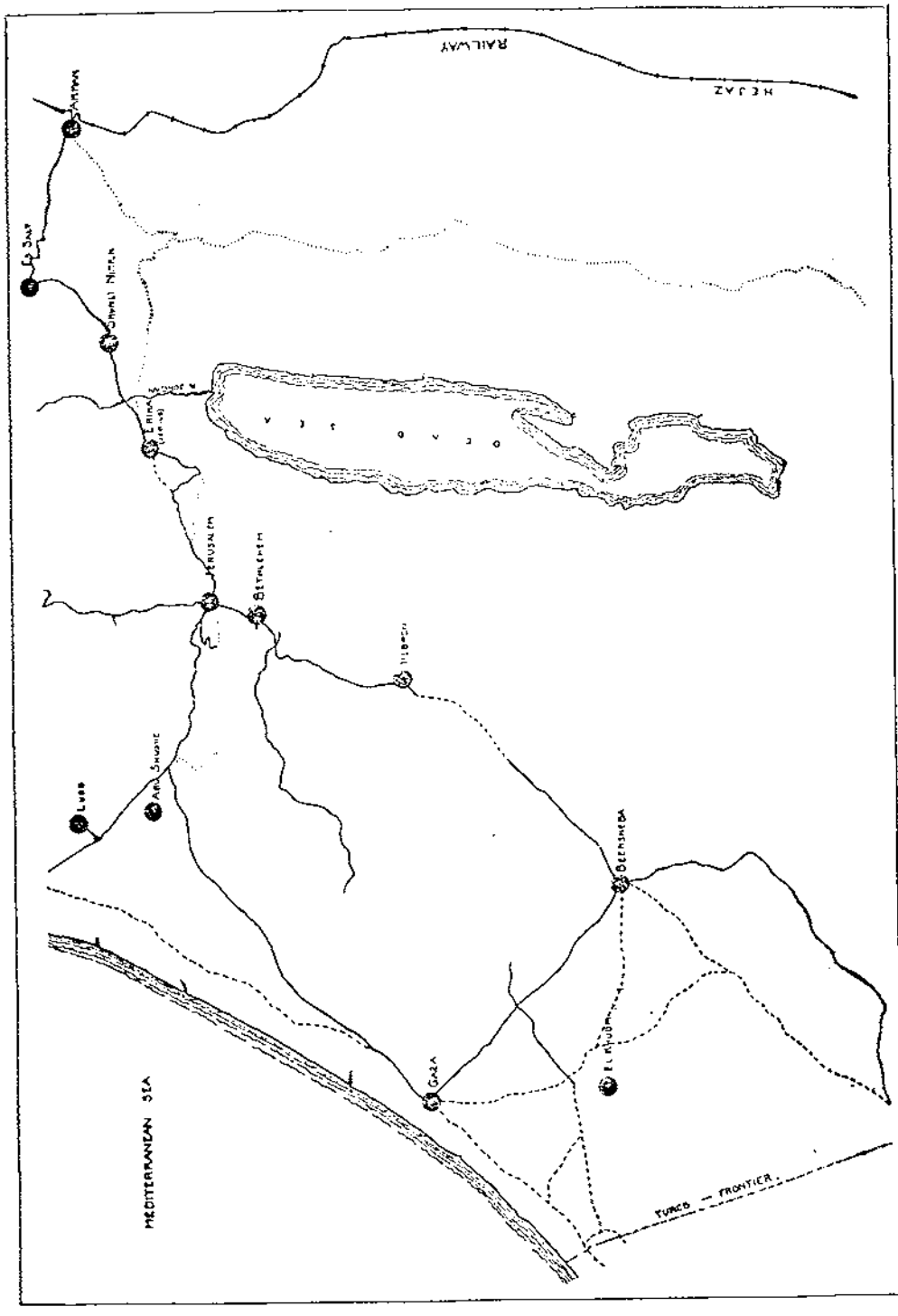
There was hard fighting, by all arms, during the pursuit, which was pressed with vigour, till on the 15th the Hill of Gezer—or Abu Shusher—was taken by assault, and the Turkish army was cleft in two. One portion retired northwards, by the Plain of Sharon; the other went east, up the passes, towards Jerusalem.

The passes were steep, narrow, and well entrenched; it behoved us, therefore, to follow the enemy up closely, and give him no time to organize defence. Consequently, the Yeomanry Division were sent, on 17th November, *via* Bethoron, to move on Birch (Bethel). The 75th Division took the road to Jerusalem, *via* Bab el Wad; its right was guarded by the Australian Mounted Division. The 52nd Division went up the Valley of Ajalon (Yalu) towards El Jib (Gibeon).

The Ridge was won, but bad weather, difficult ground, strong resistance by the enemy, and the exhaustion of our men brought about a pause, and not until reinforcements became available could the Turks be driven from their last positions.

Finally, they withdrew northwards, towards Mount Ephraim, and eastwards towards Jericho.

Jerusalem was handed over by the Mayor on the 9th and our official entry was made on the 11th December. Meanwhile, the



Southern Palestine.

Anzac Mounted Division and some of the XXI. Corps had occupied Jaffa on the sea coast, and faced the Turks on the Plain of Sharon.

During December, the enemy made a great effort to retake Jerusalem from the north, and there was hard fighting, but by the end of the month we were quite firmly established.

The next few weeks were devoted to improving communications, replenishing supplies and ammunition, and to preparations for the crossing of Jordan. There was sharp fighting in the advance to Jericho, which was occupied on the 21st February, the Turks crossing to the left bank of the river and destroying the bridge.

After minor but necessary operations to gain space and freedom of manœuvre, we crossed the Jordan on the 21st March. An operation was then undertaken, a raid against the enemy's communications in Gilead, to break the line by which he supplied those of his troops who were opposing our Arab allies in the Hedjaz.

The 60th Division, the Australian and New Zealand Mounted Division, the Imperial Camel Corps Brigade, with attached troops, all under command of General Shea, carried out the raid.

Its object was to cut the Hedjaz railway, at Amman, and to join hands with the forces of King Hussein of the Hedjaz who were under the command of Sherif Feisal and Colonel Lawrence. Operations were hampered by exceptionally cold and heavy rains; but Amman was reached, and the railway cut, though only temporarily. We then withdrew, and by the 2nd April had recrossed the Jordan, leaving only a bridgehead guard on the left bank of the river.

Another raid was undertaken at the end of April, by two Divisions of the Desert Mounted Corps and the 60th Division. The object was to cut off a body of 5,000 Turks who had occupied the pass of Shunet Nimrin in the Jordan Valley, also, by seizing Es Salt, to deprive the enemy of the harvest from the cornlands of Gilead and Moab.

Es Salt was gained; but enemy pressure was heavy, and its retention would have been too costly, so our troops were withdrawn.

These two raids, though not completely successful, had the good result of making the enemy very nervous, and they caused him to detach troops which relieved pressure on our Arab Allies and elsewhere.

During April, two British Divisions, the 52nd and 74th, were sent to France, as well as nine Yeomanry regiments, five and a half siege batteries, ten British battalions and five machine-gun companies. By the end of April, these troops had been replaced by Indian Cavalry and Indian Infantry. In May, fourteen more battalions of British Infantry were withdrawn for France, and, in July and August, a further ten battalions were replaced by Indians.

During those months, training and reorganization were continuous, but many minor operations and raids were carried out, while plans for a renewed campaign were maturing.

At the beginning of September, the strength of the enemy was calculated as 4,000 sabres, 32,000 rifles, 400 guns. The British Army, with the French and Italian contingents, numbered 12,000 sabres, 57,000 rifles, 540 guns.

The VII. and VIII. Turkish Armies, west of Jordan, had 17,000 rifles and 268 guns. The IV. Turkish Army, east of Jordan, had 6,000 rifles and 74 guns. On the Hedjaz railway were 6,000 Turkish rifles and 30 guns, while a reserve of 3,000 rifles and 30 guns were between Tiberias and Haifa.

The two raids which we had made in the spring of the year, and our maintenance during the summer of a large force in the torrid heat of the Jordan Valley, led the Turks to suppose that we intended to make our next great effort against his left.

The bulk of the Turkish armies, west of Jordan, lay south of the line—Jisr ed Damich—Nablous—Tul Keram—to the sea. Their line of communications led north; the vital points thereon being El Afule, Beisan, and Deraa. Deraa was out of our reach, but accessible to our Arabs. El Afule, in Esdraelon, and Beisan, in the Valley of Jezreel, further east, could be reached by our cavalry. El Afule and Beisan lay sixty miles distant from our left, the ridge of Carmel and the pass of Megiddo intervening.

We chose to make our attack through the coastal plain.

By reducing our strength in the Jordan Valley, and by withdrawing reserves from the line north of Jerusalem, five Divisions were concentrated, with 383 guns, in front of the enemy's right, in the Plain of Sharon; as well as two Cavalry Divisions and the Australian Mounted Division, with two squadrons of French African Cavalry.

In the Jordan Valley, Major-General Sir Edward Chaytor had the Australian and New Zealand Mounted Division, a Brigade of Indian Infantry, two Jewish Battalions and two West Indian Battalions. A mobile column of the Arab Army was at Kasr el Azrak, fifty miles east of Amman.

To ensure secrecy, movements towards and upon the coastal plain were only made by night; and the orange and olive groves of Ramleh, Ludd and Jaffa, were used as hiding-places by day. Moreover, by this time, our aeroplanes had command in the air, preventing observation by the enemy's aircraft.

At 4.30 a.m. on the 19th September, the Artillery in the Coastal plain opened intense fire—lasting fifteen minutes—while the Infantry deployed. Two destroyers assisted, by fire from the sea, against the road which follows the shore northwards.

By 5.30 a.m. the Infantry had opened a way for the Cavalry, who swept along the shore, and by noon had covered 18 miles. At dawn, on the 20th, they were through the passes and moving across Esdraelon. Afule junction was seized and Beisan was reached by evening. One brigade rode to Nazareth, capturing General Head-

quarters. Marshal Liman Von Sanders narrowly escaped by motor-car. The Australian Light Horse took Jenin at a gallop. Thus, by nightfall on the 20th September, every line of retreat west of Jordan was blocked.

Meanwhile, the Infantry attack had gone forward, through the hills of Galilee, and the Turks were driven in rout through the defiles, while aeroplanes systematically harried their dense columns by bomb and machine-gun. The fugitives, emerging on Esdraelon, and Jezreel, or crossing the Jordan, fell into the hands of the Cavalry, who held all exits. At nightfall on the 21st, the battle, west of Jordan, was at an end, and the Turkish Armies had ceased to exist, at any rate as organized troops.

In the Jordan Valley, Chaytor, on the 21st, took many prisoners at Jisr ed Damieh. He went east on the 22nd against the retreating IV. Army. On the 24th he entered Es Salt, and on the 25th he captured Amman after a hard fight. Half the IV. Army had retired north, the rest fell into his hands later on their way home from the south.

Feisal and his Arabs took a useful part in attacking the IV Army, and pushed with vigour in pursuit on to Damascus.

Without halt or check, our mounted troops chased the fleeing Turks, relentlessly following them up until Damascus was won.

The XXI. Corps followed the Coast road, by Haifa, Acra, Tyre, Sidon, to Beirut which place it reached on the 10th October. French ships of war were already in the harbour.

Damascus fell to the Desert Mounted Corps and the Arabs on the 1st October. On the 9th October, the Desert Mounted Corps pushed troops on to Homs, which was occupied on the 15th. On the 13th, the XXI. Corps Cavalry entered Tripoli. Aleppo was reached by the Mounted Troops on the 25th and some hard fighting ensued, but the town was not taken till the Armistice allowed our advanced guards to enter on the 31st of October.

In 40 days of fighting, the Egyptian Expeditionary Force had captured 360 guns and 75,000 prisoners, including 200 officers and 3,500 other ranks of Germans and Austrians. Our losses in battle had been under 5,000. Of the Mounted Troops, the 5th Cavalry Division had covered over 500 miles, losing only 21 per cent. of its horses.

After the Armistice, and during the negotiations for peace, the Turks evacuated Cilicia, and were replaced by our troops.

We occupied and held Bozanti, at the western exit of the Taurus tunnel, the bridge over the Euphrates at Jerablus, and the chief places in Cilicia.

Cilicia, Syria and Palestine remained under the Military Administration of the General Officer commanding the Army of Occupation, until the question of Mandates was settled.

THE "MECHANIZATION" OF FLEETS AND ARMIES.

By V. W. GERMAINS, *late Rifle Brigade.*

". . . THE army of the future will follow in the footsteps of the navy of to-day. Once a maritime nation could build scores and hundreds of galleys; to-day many seafaring powers cannot afford half a dozen capital ships; even in the Great War we only possessed between twenty and thirty. . . . In round numbers the strength of such an army will be 2,000 fighting machines and 60,000 of all ranks. A microscopic force when compared with the horde armies of 1914–18 . . . if the *organized* force of my sketch had existed we could . . . have decimated these hordes as surely as Alexander decimated the Persians at Issus and at Arbela . . . the artillery, or mechanical cycle of war, will reintroduce the highly professional army and conscription will be relegated to the troops of the second line, the militia which will occupy the enemy's country after his mechanized forces have been defeated, driven back or destroyed." Colonel J. F. C. Fuller, *On Future Warfare*, pp. 388 *et seq.*

The acid test of all theories is that of practical experience. We have at sea authenticated records of a process of transition from wooden ships, dependent upon man-power to handle their sails and guns, to ships of steel, dependent upon steam, electricity, and the petrol-motor for power of fighting and of manœuvre. It is a process which has endured for upwards of ninety years, which has witnessed revolutionary changes in weapons and methods and which has not alone absorbed vast sums of money in ship-construction and in experimental work, but which has been "tried out" and tested in a series of wars costing the lives of very many thousands of men. The student surveying the series of confident predictions which head this chapter might reasonably anticipate that "mechanization" at sea would have produced results at least analogous to those which it is forecasted as being about to produce on land—and he is the more justified in expecting this, since our gallant and gifted author expressly tells us that, "The army of the future will follow in the footsteps of the navy of to-day." It is somewhat disturbing, therefore, to find, at the very outset of our problem, that the actual working of "mechanization" at sea by no means supports Colonel Fuller's theories, but, on the contrary, it very emphatically confutes them.

Nelson at Trafalgar had 27 "capital" ships manned by 17,486 men. He had three frigates and a sloop. These took no part in the battle, but if they are included we get a total of 31 units with,

in round numbers, 18,500 men. Jellicoe at Jutland had 36 "capital" ships with 33,838 men; he had besides, 34 cruisers and light cruisers with 16,837 men, and 77 destroyers with 6,208 men, a grand total of 147 units with 56,883 men.* Isn't this a somewhat significant commentary upon the sweeping assertion that "mechanization" will reduce the size of armies *because* it has reduced the size of fleets? And doesn't it come as a rather baffling paradox to discover that whereas Nelson's *Victory*, a muscular ship, needed a crew of only 837 men, Jellicoe's *Iron Duke*, a box of engines, needed 1,022?

But when we consider the aggregate totals of "mechanized" and non-"mechanized" fleets alike in number of units, their cost, and the number of men needed for their complements, we are struck by the same tendency of "mechanization" to produce fleets vastly larger, and requiring vastly increased numbers of *men*. Our wooden fleet reached its maximum strength in units in the year 1809 with 728 warships displacing 501,596 tons. The high-water mark in manpower was reached the year following with 145,000 men, it kept at this level till 1812, after which it declined. In 1805, during which we faced a combination of the greatest naval powers in the world, the Navy had a strength of 534 warships, displacing 407,814 tons, and manned by 120,000 men.† In 1914, after ninety years of "mechanization," and in time of peace, we had 648 warships, displacing 2,333,223 tons and manned by 146,000 men.‡ By 1918, these figures had expanded to 1,354 warships, manned by 407,316 men, and displacing 3,247,078 tons, which does not include a modest little total of 754,111 tons, auxiliary ships, nor an office staff of 9,820, an industrial staff of 105,024, and 408,000 employed in dockyards, repairing establishments, etc. As concerns the relative cost of "mechanized" and non-"mechanized" fleets, the following figures are instructive. The year of Trafalgar cost us £15,035,630 in Naval Estimates; the years in which our wooden fleet reached its maximum strength, 1809 to 1811, brought us estimates varying from £19,578,467 to £19,822,100. The year of Jutland cost us £209,877,218, whilst the estimated cost for 1918 was £325,000,000. Not a very encouraging prospect for those who preach "mechanization" as a *cheap* method of waging war, is it?

But this does not exhaust our list of baffling paradoxes. It is part of the thesis of Colonel Fuller and kindred writers that "mechanization" will simplify the problem of leadership, it will replace "horde-armies," in which "numbers swamped efficiency," whilst according to an enthusiastic disciple it will make wars "short, sharp and decisive," and "save the blood of England's sons." But

* These are the official complements of the ships engaged as taken from Jane's *All the World's Fighting Ships*, of 1919. In reality, *Queen Mary* had 1,270 men instead of 1,000. Complements of other ships were proportionately larger.

† Clowes, *Hist. Royal Navy*, Vol. V, p. 8.

‡ First Lord's *Statement*, 1919–1920.

whereas Trafalgar was an overwhelming victory, Jutland was an indecisive battle. "Mechanization," so far from simplifying the problem of leadership, rendered this infinitely more complex, for Nelson had not to cope with mines or torpedoes, he had not to arrange team-work between battleships, cruisers and destroyers, nor had he to deal with visibility as affecting fire-control at long ranges. Nor did mechanization "save the blood of England's sons." At Trafalgar, where our entire battle-fleet was desperately engaged, we lost 1,690 men, about nine per cent. of the numbers present; at Jutland, which was in reality a brush between fleets, we lost roughly 11 per cent., and the German ships, admittedly well-armoured, lost eight per cent.

Finally, as touching Colonel Fuller's general thesis that "mechanization" has reduced the size of fleets and will reduce the man-power needed for armies, it may be of interest to glance at the actual building programmes of the British Admiralty and their effect upon the growth of the fleet in size and the man-power needed.

The low-water mark in man-power was reached in the year 1817, long before the introduction of "mechanization," with 19,000 men. From 1818–1837 it hovered between 20,000 and 30,000 men. From 1840–1853–4 (introduction of steam) it varied between 34,000 and 44,000. The introduction of armoured ships in 1857 coincided with a strength fluctuating around 60,000 men. Masts and sails did not disappear entirely from the battle-fleet until about 1880. In the decade 1881–1890 we built, counting only "capital" ships:

2 *Conquerors*	6,200 tons ..	1881 and 7
2 *Colossus*	9,420 ,, ..	1882
1 *Collingwood* ..	9,500 ,, ..	1882
2 *Howes*	10,310 ,, ..	1884
2 *Ansons*	10,600 ,, ..	1885
1 *Benbow*	10,600 ,, ..	1885
2 *Sanspareils*	10,740 ,, ..	1887
2 *Trafalgars* ..	11,940 ,, ..	1887–88

Total, 14 battleships, displacing 148,520 tons.

In 1871–1900 we built:

8 *Royal Sovereigns* ..	14,200 tons ..	1891–2
2 *Barfleurs*	10,500 ,, ..	1892
1 *Renown*	12,350 ,, ..	1893–5
9 *Majestics*	14,900 ,, ..	1894–1896
6 *Canopus*	12,950 ,, ..	1897–8–9
3 *Formidables*	15,000 ,, ..	1898
3 *Londons*	15,000 ,, ..	1899–1900

Total, 42 battleships, displacing 433,750 tons.

During this period the man-power of the fleet expanded from 60,000 in 1888 to 100,000.

In 1901–1910 we built:

2 *Queens*	.. ..	15,000 tons	.. 1902
5 *King Edwards*	..	16,350 ,,	.. 1901–3
3 *King Edwards*	..	16,350 ,,	.. 1903–5
(bought) 2 *Swiftsures* ..	..	11,800 ,,	.. 1903
2 *Lord Nelsons*	..	16,500 ,,	.. 1904–5
1 *Dreadnought*	..	17,900 ,,	.. 1905–6
3 *Invincibles* ..	..	17,250 ,,	.. 1907
3 *Bellerophons*	..	18,500 ,,	.. 1907–9–10
2 *Neptunes* ..	..	20,200 ,,	.. 1908–9
3 *Indefatigables*	..	19,200 ,,	.. 1909–11

Total of 24 "capital" ships with displacement 404,100 tons.

The middle of this decade was marked by a slowing down in building, due to the disappearance of the Russian fleet. In 1902–3 man-power had expanded to 120,000 men.

In 1911–1916 we built:

2 *Colossus*	.. ..	20,600 tons	.. 1910–11
4 *Orions*	..	22,500 ,,	.. 1911
2 *Lions*	..	26,350 ,,	.. 1911
4 *King George V.*	..	23,000 ,,	.. 1911–12
4 *Iron Dukes* ..	..	25,000 ,,	.. 1912–13
2 *Tigers*	.. ..	28,500 ,,	.. 1913
5 *Queen Elizabeths*	..	27,500 ,,	.. 1913–14–15
5 *Royal Sovereigns*	..	25,750 ,,	.. 1915–16
2 *Repulses*	.. ..	32,000 ,,	.. 1916

Total of 30 "capital" ships, displacing 747,150 tons, and built over a period of 6–7 years.

Excluding *Queen Elizabeths*, *Tiger*, *Royal Sovereigns* and *Repulses*, we built in five years preceding the declaration of war 17 "capital" ships, displacing 398,400 tons. The man-power of the fleet expanded from 120,000 to 146,000 men. Many more men would have been required but for Fisher's policy of "scrapping" obsolete ships. In the two years preceding the War we had a yearly average of 179,800 tons of warships under construction, nearly one-half of the total warship tonnage in 1805, and more than one-third of the total tonnage in 1809, the year of the maximum size of our wooden fleet.

In the period July 1st, 1915–June 30th, 1916, we had built 522,239 tons of warships, which actually exceeded the total tonnage of 1809.

These figures, however, are a conservative estimate. They do not include several ships, such as *Erin* and *Agincourt*, bought or confiscated for naval purposes on the outbreak of the War, and they do not picture the intensification of effort due to the short "life" of the modern warship as compared with the long "life" of the Nelsonic ship-of-the-line. *Victory*, launched in 1765, was still a first-class

unit in 1805, and for many years after. Jellicoe's oldest battleships at Jutland were *Bellerophons* and *Neptunes* (1907–8–9).

The super-*Dreadnoughts*, *Orions*, *King George V.*, *Iron Dukes*, *Queen Elizabeths*, were babies in arms compared with *Victory*, infants of one and two; tiny toddlers of three and four years old. Taking period for period, a comparative statement of our fleet of 1916 with that of 1805, would include ancient *Admirals*, long broken up for the scrap heap; we should reach a total of close upon 100 battleships, which would rival even in point of mere numbers the battle-fleet of Nelson's days (116 sail of the line), whilst far exceeding these in man-power needed, displacement tonnage, and cost. The year 1914 actually found us with 70 "capital" ships instead of "between 20 and 30," as Colonel Fuller imagines, for our pre-*Dreadnoughts*, much more powerful than the German *Pommerns* which were actually present at Jutland, formed a very valuable reserve. It may be added that the vast expansion of the British "mechanized" fleet here described was even exceeded by that of the German, American and Japanese navies, in the period 1898–1916.

The actual course of "mechanization" at sea thus by no means supports the views of those who hold that "mechanization" on land will mean smaller armies and reduce the man-power necessary for these. The explanation of this apparent paradox is that these theories are based upon an economic fallacy. Labour-saving machinery does not displace human labour; on the contrary, it increases the demand for human labour, and the more machines we have, the more we shall need men. A glance at peace-industry reveals the tremendous growth of great industrial cities and an enormous increase in the number of operatives employed in industry.*

The tendency of fleets and armies to expand in size, the power of their weapons, the man-power needed to use these weapons, and of leadership to become more complex, is thus part of a general tendency of social organisms to expand in growth and of social leadership to become more complex. Is it wise to jump to the conclusion that this tendency, which has been continuous for centuries, and which has been helped and not retarded by labour-saving machinery, is, in its purely military aspects, about to undergo a sudden change eccentric to the general movement of social communities?

In dealing with a problem which is many-sided and complex, the student will be well-advised summarily to dismiss a great many fanciful analogies between tanks and barbarian horsemen; or tanks and battleships. The decay of the Roman Empire was the collapse of a political, and not of a military organism, and whereas it is impossible for a man to fight at sea standing on his own legs without support

* The population of England and Wales increased from 8,892,536 in 1801 to 37,886,699 in 1921; that of Germany from 24,831,396 in 1816 to 69,656,259 in 1925; that of U.S.A. from 5,308,483 in 1800 to 105,720,620 in 1920 (*Statesman's Year Book*, 1928). These are the three countries in which there have been the largest developments in labour-saving machinery.

from a floating surface, he *can* do this on land. We cannot solve modern military problems by returning to the shibboleths of the eighteenth century, and in putting forward naval analogies, full allowance must be made for the very great difference in the technical problems involved. The sea is a vast plain; save where shoal-waters, rocks or narrows intervene, there is nothing to hamper movement nor, save for sea-fog, is there any bar to vision. This vast plain is threaded by trade-routes; war at sea resolves itself largely into the attack or defence of these, and "command of the sea" may be interpreted as the power to deny movement across the sea to an enemy whilst preserving freedom of movement for one's own side. Save for political considerations such as the Washington Conference, or the necessity of being able to use existing docking accommodation, there is no bar other than cost on the battleship's size; on the contrary, increased size means an actual economy in engine-power, first costs, and maintenance costs.

Yet even with these advantages the battleship represents a compromise between divergent elements in speed, armament, armour, and endurance. This compromise, which is inevitable, renders the battleship dependent upon light cruisers, cruisers, destroyers and submarines for scouting, "screening," commerce-protection, and blockade work. The battleship herself, whilst massively armoured, is built to fight at immense ranges; she can calculate her rolling "period," avail herself of "spotters" and "directors" to control her fire; she is armed with, save for "Big Bertha," the heaviest guns known to man, and is built to challenge the similar weapons of an enemy. Conditions on land are vastly different. There are such things as mountains, swamps, rivers, forests, great cities, towns, villages, all of them very serious obstacles to movement and vision. The tank is cramped as to size by the necessity of being able to utilize roads, railroads and bridges, and, above all things, by the necessity of reducing the size of the target, for her entire body is exposed to fire, whereas the bulk of the warship is submerged, and thus protected. Like the warship, she is a compromise between divergent elements in the way of speed, guns, armour and endurance, but unlike the warship, she is not free to increase her size. Her armour is protective only against infantry weapons, she cannot face the smallest quick-firing gun, and, considered as a gun-platform, she can neither calculate her "period" nor "register" on her target. If it is to be a *fire-fight* between the gun mounted on a tank and a gun of equal power stationary, no one can have any doubt as to what would happen.* The tank's real weapon is—shock tactics. If she can rush the gun before she gets "smothered," she can crush it either

* Col. Collins, Commandant of the Experimental Mechanized Force, said, in answer to a question by Capt. Oldham, R.N., ". . . we cannot get the gunnery efficiency in movement you have. . . . You have only to spend a few minutes in a tank to realize the great difficulty of bringing efficient fire to bear in movement."—*R.A. Journal*, April, No. 44.

beneath her weight or by a rain of machine-gun fire with A.P. bullets at point-blank range. The tank is thus a close-quarter weapon like the destroyer, and success is largely a matter of moral effect and the exploitation of surprise. The greatly increased area to be protected as compared with the armoured ship, and the practical limitations on the size of a tank, render the problem of increasing the weight and thickness of armour to meet the menace of an improved anti-tank gun very complex. One cannot get something for nothing. Speed is perhaps the costliest item, armour comes next, the gain, if any, must be met by increased mechanical efficiency; one does not, however, increase the mechanical efficiency of one's engines 100 per cent. to 200 per cent. at one fell swoop. A possible solution is to increase the length of the tank, but we have to face the problem of road-curves, stresses on bridges, railroad-capacity. No doubt we shall get ultimately a multiple-tracked tank, and the "electric drive" may possibly afford a means of working with separate gun and power-houses, and "articulated joints," so as to be able to follow road and railroad bends.

But, however powerful the tank, the anti-tank gun will always move to meet it; the man fighting on his own feet will always have certain solid advantages over the man fighting mounted on a machine. The student is apt to be confused by hasty generalizations. He has such phrases as "Reign of the Bullet," "Half an inch of steel to cancel out half an ounce of lead," etc., literally hurled at his head. But there is nothing sacrosanct in the word *armour*. The resisting power of any steel plate depends upon the weapon which attacks it. Not alone this, but armour which is not protective becomes an added source of danger. The top of a turret will intercept a shell which would otherwise have passed over; the thin plate will cause a shell to explode destructively which might otherwise have gone "clean through." Tanks designed in defiance of these principles may become mere death-traps for their crews. Difficulties in the way of increasing tank armour have already been touched on. Increased length will mean a bigger target, a greater area to be protected, and it is difficult for the tank-designer to follow the path of the battleship designer and to concentrate armour on "vitals." It is, after all, a much cheaper policy to experiment with anti-tank guns than with tanks; the technical problems to be solved, whilst difficult, are much less so than that of tank-armour. The ultimate issue will undoubtedly be a heavy machine-gun comparing with that of to-day as the quick-firer compared with the breech-loader; a weapon in which the recoil will be so modified as to render it possible to use a very light tripod. Such a weapon will be a two-man load, and could be handled almost as easily as the present-day Lewis gun.* If it comes to a fire-fight the odds are heavily on the anti-tank gunner who can see his target clearly, and fire stationary, whilst himself almost invisible to the gunner on

* We could undoubtedly produce such a weapon *now*.

the tank. And the student must take to heart Farragut's words: "The best protection against the enemy's fire is the fire of our own guns."*

The differing conditions of warfare by land and sea render it impossible to produce a tank truly equivalent to the "capital" ship.† The naval officer if asked to risk his battleships in cramped regions such as the Baltic, which involve handicaps upon movements analogous to those on land, very wisely declines to do so. The real equivalent on land to the "capital" ship is the "mixed division," which, made up of infantry, artillery, auxiliary units, and with an allowance of aircraft and tanks, forms in reality a "team," the composition of which can be varied in accordance with ground, but which looks for success to the co-ordination of arms, whilst it compensates for relative slowness of movement by the sheer element of weight and power. Much which is written upon "mechanization" fails to realize the importance of team-work between heavy gun and anti-tank gun,‡ and to make allowance for the interaction of arms and its bearing upon the *engineering* aspect of the problem. Although it is sometimes possible to get higher speed with a bigger engine and a heavier vehicle, this does not affect the general principle that speed means the sacrifice of *weight*. Take *Repulse*, of 32,000 tons displacement, and compare her with *Royal Sovereign*, displacing only 25,750 tons. From the absolute standpoint *Repulse* is a bigger and heavier ship, but from the tactical standpoint she is a much lighter ship, for her superiority in speed (she is a battle-cruiser) is gained by great sacrifices in guns and armour. Applying this reasoning to the land, it is obvious that the power which we take to move a self-propelled gun attached to a rapidly moving cross-country "mechanized" unit, if applied to a gun meant to move with a relatively slow-marching column of infantry, will move a weapon greatly superior in weight and range.

Thus, in the near future, our self-propelled 18-pdr. is likely to come up against 4-in. or 5-in. guns—working hand in hand with anti-tank gunners. With this in mind, consider the plight of the "mechanized division" such as is protrayed by Colonel Fuller and other writers—pitted against the "mixed" division. Apparently, the theory is that the "mechanized division" can work to a flank, its guns can enfilade "a long line of guns," which cannot "refuse a flank or retire fighting. . . . Then tanks moving up by covered approaches will break the line centrally and will enfilade it in both directions." Confronted by this horrific "wision," Colonel Rowan Robinson can see nothing

* "The War has proved that an adequate provision of fire-power is the best antidote to heavy casualty lists." Major Brook, "Evolution of Artillery in the Great War," *R.A. Journal*, January, 1927.

† *Vide The 'Mechanization' of War*, by the present writer, for a more detailed comparison between tank and warship-design.

‡ Col. Rowan Robinson in *Artillery: To-day and To-morrow*, completely overlooks this point.

for it but to crowd our entire army into tanks, mechanize field artillery and to use it in large groups under " control from the air."

Passing the practical difficulties in the way of controlling from the air what is, by hypothesis, a rapidly moving force on land at death-grips with an enemy, surely it is quicker and easier to move across the *chord of the arc* than around it? The commander of our " mixed " division, if competent, will be just as much alive to the danger of being outflanked and enfiladed as the commander of the " mechanized " division will be keen to do this. Unless, therefore, attacked simultaneously and frontally by a force of equal power he will have his patrols widely thrown on either flank, watchful and wary, fire-zones mapped out, part of his artillery ready to be transferred to the threatened flank, heavy guns ready to slam down a barrage so soon as tanks are reported; anti-tank gunners ready to be crowded on motor-lorries and rushed to occupy a fighting line.* What is likely to happen? The enfilading self-propelled guns must be either stationary or in motion. If in motion they sacrifice accuracy of fire, bumping and jolting, their shooting becomes little more than an advertisement that an attack is in progress. They and the tanks with them will come under fire from anti-tank guns, firing armour-piercing bullets, and an artillery fire of increasing intensity. On the other hand, the self-propelled guns may take up positions from which, firing stationary, they can cover the attack of the tanks. If they do this, how long will it be before they are " smothered " by the heavier metal which will be brought against them? What are the exact chances of tanks " charging " infantry armed with machine-guns capable of piercing their armour at 600 yards and at an angle of 45°? Isn't it likely to work out into a new edition of the French Cuirassiers at Sedan?

One must never forget that, in Napoleon's phrase, " one cannot manœuvre except around a fixed point." Unless there is a frontal attack sufficiently powerful to hold the " mixed " division to its ground, the advantage of " outflanking " is more apparent than real. An enemy on the alert can always change front in time to meet it. At Jutland, the British battle-cruisers actually performed an analogous manœuvre when they crossed the German T. Scheer extricated himself by his " turn all together." Yet the British fleet was vastly superior to the Germans in speed and gun-power. The naval manœuvre of " crossing the T " and of getting an enemy into the " cauldron," however, pre-supposes no loss in accuracy of fire with the vessels performing this manœuvre. The trouble on land is that the gun in movement, unless upon an absolutely billiard-table-like surface, sacrifices accuracy to an alarming extent. The tactics suggested thus actually work out into a thing reminiscent of the Indian stories of our boyhood, Comanches dashing around a wagon-

* Very possibly he would cover his flanks by minefields.

lager, firing sheltered behind their galloping horses. Such attacks usually ended disastrously for those who made them.* That the "mixed division" can much more than hold its own when acting on the defensive needs, I think, no further demonstration: the real problem is: Can it protect itself while in movement? This is a matter upon which I write with some diffidence, for my views are in conflict with a very distinguished soldier for whose opinions I entertain profound respect. The theory is that the "mechanized" division will circle around the "mixed division," thrusting at its rear and flank-guards, and producing a state, at the very least, of "alarums and excursions" which will paralyse movement. The problem seems to me to be one very much of leadership. If the "mechanized" commander is a Ziethen and the "mixed" commander is a dud, these things could undoubtedly happen. But given good leadership the commander of the "mixed division," if aware that he is liable to be attacked, will not move in column of route but in a *bataillon carré* formation, with his baggage in the centre, his aircraft sweeping far overhead, screens of patrols thrown forward and on either flank. He will have given "battle-orders" as to what is to be done when tanks are reported, and everyone will be on the alert. The time required for his own guns and anti-tank guns to come into action would be measured in minutes, and it does not seem unreasonable to suggest that, with a protective screen sufficiently well arranged and far ahead, he should be able to secure these few minutes. Given highly trained, disciplined troops, the charging tank will then be met by a cyclone of fire.

The "mechanized division," at least of the type put forward, is gravely handicapped as compared with the old cavalry division, which could not alone live on the country but dismount its men for a "set-piece" attack. A point which has always puzzled me is how our "mechanization" enthusiasts propose to deal with *forts*.† Are they to fall like the walls of Jericho to a chorus of "scientific" declamation? Commonsense teaches that such points as bridges, tunnels, railway-junctions, etc., vulnerable to raids, will be fortified and, in all probability, girdled with mines. Is the "mechanized division" to charge these forts? If not, it must have infantry and be prepared to make a "set-piece" attack.

The combination of "mechanized" division with "mixed" division may be compared perhaps with that of destroyers and battle-

* Beatty was a very daring leader, but if he had handled his battle-cruisers at Jutland in the fashion some of our writers suggest for a "mechanized" unit on land, not a man would have escaped to tell the tale.

† It is suggested that infantry should be carried in "armoured" vehicles. If infantry need an armoured "Cook's Tour" to get to the fighting point, they won't be much good when they get there. Also, the plight of the infantry crowded like sardines in a vehicle which will be a magnet for every hostile gunner, just sufficiently "armoured" to ensure that a shell will burst with the maximum possible effect, will be far from enviable.

ships. The true *rôle* of the "mechanized" division will be to "screen" the "mixed" divisions, *to exploit the opportunities created by these*, and if necessary to sacrifice themselves by desperate counter-attacks to extricate their own army from a dangerous situation.

In summing up, judging from what has happened at sea and in peace-industry, there seems to be no bright prospect that "mechanization" will reduce the size of armies, their cost, or the complexity of leadership. On the contrary, it is much more likely to increase all these things. The more highly industrialized a nation, the *greater* the percentage of its manhood it can put in the field, *e.g.*, France and Russia. The gun, rifle, machine-gun, etc., are all just as much machines as the tank: to gain *mobility* we must sacrifice *weight*, and it will always depend upon circumstances whether this sacrifice is justified. The menace from the air, and raids by mechanized forces, are likely to lead to a development of the system of ring-fortification, and this will be very expensive in men and guns. The principle of *concentration of strength* will affect the operative size of armies—no General Staff will be anxious to indulge in "side-shows"—the principle of *enforcement of a decision* will lead to "speeding up," for every government will be anxious to avoid a long-drawn out and indecisive struggle. It is unwise to accept the assertion that a conscript army cannot effectively use "mechanized" forces. Although war at sea is a highly technical process, the short-service conscript German seaman gunner was not, at Jutland, markedly inferior to his British long-service professional *confrère*. It is equally unwise to accept the conclusion that because France has, say, 600 miles of frontier to defend, she cannot produce a "mechanized" army on as great a scale as ourselves. On the contrary, the more France is exposed to attack, the greater the effort she is likely to make for her defence. The last war saw conscription of men to serve machines (rifles, guns, etc.); the next war will see conscription of women, children and old men to serve machines in munition factories, and conscription of even more men to serve machines in battle. In other words, should the British Empire be pitted in war on land against a power as formidable as was Germany, the call for national effort and national sacrifices will be even greater than in the last war, and it is hopeless to believe that such a struggle can be fought to a victorious end by our tiny regular army—even if fully "mechanized"—whilst the rest of the nation cheers them on to the slogan of "business—and pleasure—as usual."

THE ERECTION OF A 150-ft. WIRELESS MAST.

By No. 9 Field Company, Q.V.O. Madras Sappers and Miners.

The mast to be erected consisted of six sections of steel piping, internal diameter 4 in. and external diameter 4½ in., weighing 10¼ lb. per foot run. The lengths of the sections varied so that the joints, which were of the flanged type, should coincide with the points of contraflexure in the mast when strained by a wind. It was to be guyed at 50-ft. intervals, by three 1½-in. S.W. guys at each point. The designer had apparently made no allowances for stresses in erecting, as it was proposed that a scaffolding should be put up 150 ft. high from which the mast could be erected. A contractor was found who, after making all the necessary holdfasts, fixing the foundations and making up the guys, considered it his best policy to disappear. No contractor would undertake completing the work, and finally it was given to No. 9 Field Company, Q.V.O. Madras Sappers and Miners.

The flimsy nature of the mast at once ruled out any normal method of erection. The general principle worked on was to place the top section vertically on the ground, then to attach a tackle to the lower end and lift it, keeping it vertical by means of guys, until the next section could be slipped underneath and bolted on, repeating the process till the mast was complete.

The first photograph shows the apparatus used. The two sheers were erected facing each other so that the centre point of the quadrilateral formed by their feet was 18 in. to one side of the base section, which had already been set in concrete with 10 ft. projecting above ground level. The long sheers on the left were duplicated in order to give the necessary strength. The photograph was taken during the second lift, the length of mast being lifted is 63 ft., and the next section to be added (26 ft. long) can be seen lying on the ground between the sheers. The top guys with their insulators and the halyards for erecting the aerials can be seen. Between the crutches of the sheers are four temporary guys, whilst the clamp for the 100-ft. height guys can be seen between the two bamboo stagings. As these points passed the top of the long sheers, the temporary guys were cast off and the permanent guys fixed. The second photograph shows the next section being bolted on, and the wire guys which have just been attached to the 100-ft point. To provide a suitable hold for the lifting tackle, two sleepers were bolted together, one each side

of the tube, the sleepers being shaped slightly so as to fit the tube. This provided a perfectly secure fastening for the tackles and did not slip for loads up to 2 tons. The lifting force was provided by a 10-cwt. winch working on a 3-3 tackle. (Photo 3.)

This force was transmitted to both ends of the sleepers bolted across the mast by means of a bridle. Between the bridle and the 3-3 tackle was a 5-ton tension meter. Photos 3 and 4 show an N.C.O. reading the meter, the two halves of the bridle emerging from the " single block bridle hand " and the two halves of the " reins " then passing through leading blocks on the sheer legs from where they pass over the top pulleys of the sheers and are made fast to the sleepers. This ensured an even pull on both ends of the sleepers and eliminated any tendency to twist the mast.

The party used on the work consisted of 2 B.O's., 1 B.N.C.O., 2 I.O's. and 100 I.O.R's., who were distributed as under :—

9 Guy parties each ...	1 N.C.O.,	3 Sappers		36
Temporary foot rope men		8	,,	8
Winch party	1 N.C.O.,	3	,,	4
Tension Meter	1 ,,			1
Bolting-up party ...	1 ,,	4 Sappers		5
2 Plumb-bob parties each	1 ,,	3	,,	8
Stores	1 ,,	2	,,	3
Spare men	—	—		26

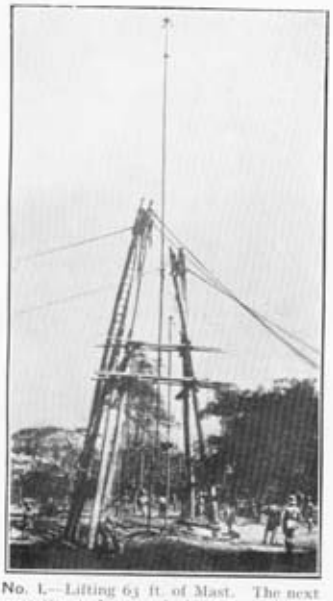
The spare men were essential for carrying up sections of mast, holding temporary guys, etc., as none of the other parties could leave its post. The plumb-bob parties each worked with a plumb-bob, their lines of sight meeting at right-angles at the mast. The N.C.O. in charge compared the line of the mast with the plumb-bob. Each plumb-bob consisted of a bamboo tripod and a large stone suspended by a piece of thin brass wire into a bucket of water, which prevented it from swinging about in the wind. The N.C.O. would then order his sappers to give signals with different coloured flags, indicating the positions of the top of the mast, the point of attachment of the middle guys, and that of the bottom guys with reference to the vertical. The whippy nature of the mast made these precautions necessary.

The procedure of lifting was as follows :—

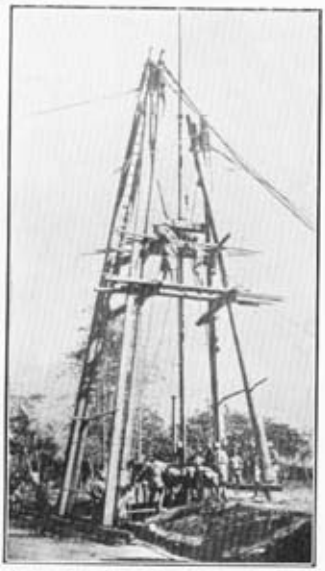
(*a*) Sleepers bolted across the bottom of the mast and tackles fixed and the load taken by the winch.

(*b*) Plumb-bob parties start signalling. From their signals, the officer in charge of the work adjusted the top guys, and the second officer adjusted the intermediate guys until the mast was not more than 4 or 5 inches out of the vertical at any point. To correct the mast, guys were as far as possible slackened off (the officer specifying the amount) and never

THE ERECTION OF A 150-FT. WIRELESS MAST.



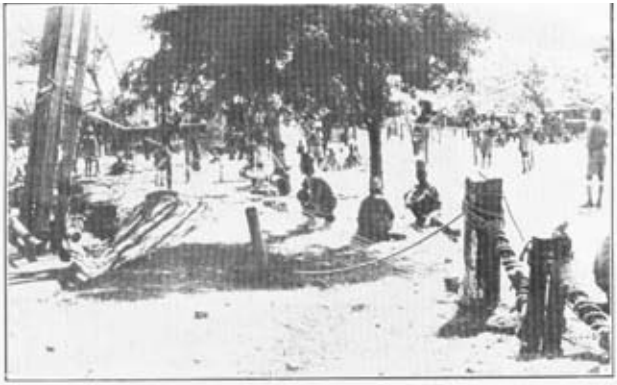
No. 1.—Lifting 63 ft. of Mast. The next section to be attached is lying next to the base section.



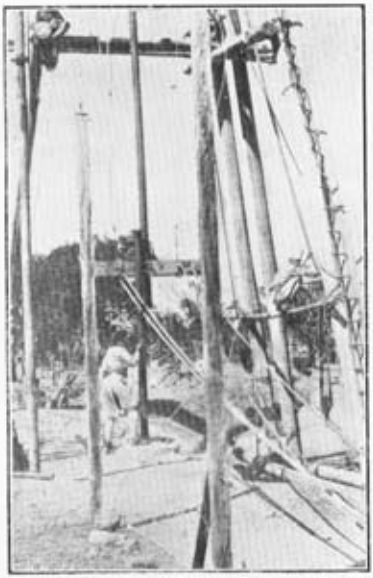
No. 2.—Attaching the fourth section. The middle guys have been fixed. They will be pulled tight when clear of the sheers.

No. 3.—Winch and 1 in. S.W.R. 3-3 Tackle. The centre of the Bridle is seen on the left. An N.C.O. is seen reading the tension meter. The Sappers behind him are holding a foot rope.

150ft Wireless Mast



No. 4.—Lifting tackles showing bridle



No 5.—The final lift; traversing and twisting tackles fixed. *Note.*—Rope tackle on right used for lifting single sections.

The Final Lift

tightened. The guys themselves were turned round a temporary picket holdfast placed as near the permanent holdfast as possible. The Indian officers watched that N.C.O's. carried out orders exactly.

(*c*) The officer in charge orders the winch to take in. As the mast rises, the N.C.O. on the tension meter calls out the readings, and the plumb-bob men signal the actions of the mast. When the tension meter registered $1\frac{3}{4}$ tons the winch was stopped and the mast trued up again. Then, if the meter still registered over $1\frac{1}{4}$ tons, the tier of the guys which appeared tightest were loosened 3 in., which usually brought the load down by 10 cwt. It was found impossible to raise the mast more than about 8 in. before the load became excessive.

(*d*) When the mast had been lifted about 2 ins. higher above ground level than the length of the next section the latter was erected underneath and bolted to the mast securely.

(*e*) The mast was then lowered about 2 in. on to packing, and the sleeper grip taken off and attached to the bottom again, ready for the next lift. The longest section of pipe put in was 29 ft. 6 in. which necessitated a clear lift of 30 ft.

The final lift and traverse of 18 ins. was effected by paying out the guys unequally. Photo 5 shows the mast during the last lift, with a tackle on each end of the sleeper grip, by which the bottom of the mast was pulled over the last 3 or 4 inches, and twisted so as to make the bolt holes in the flanges correspond exactly. The guys were finally made fast to their holdfasts and adjusted. The guys on the whole gave less trouble than was expected; they seldom had a pull of more than 100 lb. in them, and it was found quite easy to pass the insulators round temporary holdfasts.

The actual dead weight of the mast and guys was just over 15 cwt., and it was roughly estimated that the effect of the tension in the guys would increase this by a ton. The tackles and sheers, etc., were calculated to take a load of 2 tons. The tension meter was of great assistance to the officer in charge as it prevented the possibility of over-straining the tackles by taking in more on the winch than the guys could allow.

The whole work, including transporting all stores from Bangalore to Hebbal, a distance of 5 miles, and returning again, occupied exactly one week. The work was of a great instructional value in that materials were being used to their safe limit and that the success of the work depended on every man carrying out his work exactly—two points which are not obtained in any ordinary field work course.

WORKS SUPERVISION AT HOME.

By CAPT. J. C. P. TOSH, M.C., R.E.

THIS article is written as a result of experience of the Reconstruction Scheme at Catterick Camp during the last few years and it is intended mainly to help those who find themselves in charge of such work with little previous experience. The work is now nearly completed, and whatever opinion there may be as to the success of the Scheme, there is no doubt that the supervision of work on such a large scale has demonstrated many important points which are not so clearly perceptible amidst the mass of routine work and paper included in the work of the average Division Officer. The important thing to realize from the start is that the Supervising Officer, or D.O., will find that he has more to do than he can manage. He must economize his time by looking ahead; if he waits for difficulties to turn up, he will be rushed off his feet with minor troubles and lose his power of intelligent forethought, with drastic results. This sounds like a platitude, but it is very easy for a D O. coming to a new job, faced with an orderly array of plans, specifications and bills, to imagine that there is nothing more for him to do than keep his eyes open and watch the job growing up around him. There is no greater delusion. It is of the utmost importance that the D.O. and a small staff should be on the ground several weeks before the contractor arrives with his peck of troubles. What preliminary work can be done must naturally vary with circumstances, but as a guide, the following points might require attention :—

(i) Floor levels of buildings. Get the corner pegs of buildings roughly put in and fix on floor level and decide if any break in the buildings is desirable on a sloping site. A slight alteration in the position of the building may be economical. Decide on the minimum depth of foundations, if this has not already been done. You will possibly have to go deeper in places, but you must start off with a reasonably good shot or you will have a lot of trouble later.

(ii) Lay-out of drains and roads. These are probably already on the plans, but you must check them, as they are seldom bullet-proof unless done by the man who is going to supervise the work. The drainage of flat sites requires particular attention and also the question of cross drainage to roads.

(iii) Study the contract documents. These frequently call for special agreements with the contractor as regards main-

tenance of existing roads, supply of electricity and water from W.D. sources. Make up your own mind as to what is fair and get out draft agreements and maps where necessary ready to present to the contractor. He may disagree and the draft may have to be amended, but you will have the great advantage of knowing your own mind on the matters and much time will be saved.

You may also find that certain conditions of the contract are not very suitable for the locality and may be able to get these altered before they cause friction. For example, your specifications may state the foundation concrete is to be—1 : 3 : 7—you find the local resources consist of good pit run gravel, containing approximately the right proportion of sand and stone which is normally used in the district for mass concrete. It would obviously be carrying the letter of the law too far to attempt to insist on the contractor's screening and re-grading all his gravel, and the specification should be altered accordingly to one part cement to eight parts pit run gravel, which is about the corresponding mix.

It is also possible that some details of design are not at all suited to the locality and require alteration. For example, ground floors laid on fillets bedded direct on the concrete seal are commonly used in economical designs, but in some instances, notably in the case of sloping sites, the fill underneath them may be considerable, and it is necessary to work out the economical limit of filling above which ordinary joisted floors become more economical. On some sites where the soil is a strong clay, any depth of filling is impossible, and, further, all seals must have hard core under them, which is normally omitted from our specifications. These things are simple enough if instructions are given in good time, but cause a lot of trouble if left till the brick-laying begins.

It is also well to have a look at the specifications and compare them with local resources as regards such universal materials as bricks, sand, stone, gravel, etc., and decide what standard you are going to adopt. In many cases you will find that materials strictly in accordance with the specification are not available, and it is useless to try to insist on the contractor importing large quantities of common materials from other parts of England. If you have time, have a glance through the items for which Prime Cost sums are allowed and get some idea of the class of article you think suitable. It is hard to think straight later on, when you are immersed in details of all kinds. For example, in superior buildings such as officers' messes, P.C. sums are generally allowed for the grates and mantelpieces. If left

to himself, the contractor will probably send four or five drawings of such articles, with a request for an early decision as he is nearly ready for them, possibly you are not much impressed by any of them and cannot judge from the drawings what they will really look like, but time presses and you finally plump for the least objectionable. It is much better to be able to consider the matter quietly beforehand and tell the contractor the type you consider most suitable, and ask him to get quotations.

The question of plans is a difficult one; they will normally be on a scale of eight feet to the inch, and in these days of strict economy in space, a few inches may defeat you completely. You should put your draughtsman on to the more important plans at any rate, and get him to check such troublesome details as stairs, door clearances, etc., and prepare details as required. Sculleries are nearly always a difficulty and a detail plan showing position of sink, draining board and plate rack (with reference to the size of a plate) is nearly always necessary. The question of adapting the various standard cupboards to the plan also requires attention. See that the eaves in small houses do not prevent the upper floor casements from opening. The plans of special buildings, such as bakeries, special stores, hospitals, etc., require careful scrutiny; even though approved by various departments they are apt to give rise to snags. Put yourself in the position of the baker, the butcher, the stretcher-bearer, the patient; cut out to scale cardboard plans of trollies, handcarts and stretchers and see that they will go round corners and through doors. It is your job to make a real workable scheme, not to take refuge behind approved plans!

Other preliminary work may include the preparation of stores orders, drafting special contracts such as for heating, asphalte, fencing, etc., and preparation of colour schemes, external and internal. All these things can be, and frequently are, done during the contract, with the result that you have to rush them and are too worried with constant difficulties to look ahead; a vicious circle is started from which you never emerge and life becomes one series of regrets that certain obvious mistakes were not foreseen in time.

We now pass to the time when the contractor arrives on the site. It is the universally accepted duty of the D.O. to secure economy, efficiency and compliance with the specifications. It is not, perhaps, so generally recognized that you must also work for punctuality and, above all things, peace. It must needs be that disputes occur and that many will have to go to higher authority, but every effort must be made to nip them in the bud. The bigger the contract, the more widespread is the competition for it, and consequently the finer cut will be the prices of the successful contractor. It follows that the contractor cannot be expected to go one inch beyond the conditions of his contract; he cannot be called upon to do anything which is not clearly included in his bills, though they may be hinted

at in the specification and, above all, he cannot be expected to solve unforeseen difficulties which may crop up. I mention this because frequently with small Part II Services a local contractor gets the job at his own price and goes out of his way to put it through satisfactorily. This must never be expected as a right.

It goes without saying that the contractor and his staff may be expected to have a life-long experience of the intricacies and tricks of the trade and the legal aspects of contracts. Moreover, in many cases his agent and staff worked together before; he is free to employ or dismiss whoever he likes, and, generally, has few restrictions. You, as D.O., on the other hand may or may not have had much experience. You have many regulations to hold you down. Your staff is probably detailed by someone else and taken from you without appeal when occasion demands it. A contractor will frequently give a good foreman ten pounds a week and a house and perquisites to ensure keeping him as long as wanted, while the D.O. may have his best foreman of works detailed for foreign service at a critical period. You can seldom get rid of men you do not like, and you are not the final arbiter in case of dispute. A further word of pessimism: you must not look on the contract documents as if they were the Ten Commandments, as many of its clauses may be open to argument.

How then are you, with all these disadvantages, to keep your end up with the contractor? Firstly, by maintaining absolute fairness in your dealings. It goes without saying that you should honour your written and spoken word, but you should also honour the impressions you have given, however much you regret it. If you have seen an operation going on for some time and made no remark, and later discover that it is not quite in accordance with the specification, you should not condemn it, having previously given the impression that it was satisfactory. Further, you must be fair to the sub-contractor. Officially, the sub-contractor is not supposed to come into contact with you at all, but in practice he must, to some extent. Beware of coming to a final agreement with the sub-contractor instead of with the contractor, as the latter may then claim to be relieved of responsibility; by all means, in case of difficulty, hear what the sub-contractor has to say and ask his advice if you like, but make the agreement with the contractor. Do not be harder on the sub-contractor's work than on the rest of the work; it is very easy to be so because the sub-contract probably calls for the work to be done to the satisfaction of the W.D. and the contractor is generally ready to earn a good mark cheaply by bullying the sub-contractor to any extent. Keep to the same standard all round. I have purposely stressed this question of fair dealing, not because I have any fanatical views on the subject, but because after due experience I am convinced that it forms a far better qualification for supervising big works than any specialized training in the building trade or contract law can

possibly give. You cannot expect to " beat the contractor at his own game," so to speak ; a real sense of fairness is seemingly absent from the commercial world, and the average contractor is quick to recognize and respect it and generally slow to take advantage of it.

The contractor, especially during the early part of the contract, will have many questions to ask, and it is well to bear it in mind that some of these may not be fair questions. He may ask for instructions as to how to carry out a job, the methods of doing it being his own responsibility. For example : an underground pit has to be constructed and asphalted in wet, and the contract, as it normally does, provides that the contractor is responsible for dealing with all water met in excavation. It is clearly his responsibility to keep the site dry by pumping or otherwise, while the asphalte is being applied and to produce a dry pit on completion. He may ask you for instructions and if you give them you take the responsibility for the success of the work. Such questions should be answered only in the form of giving advice with the proviso that the responsibility for success rests with him. Fair questions must be answered clearly and the temptation to talk round a thorny point resisted ; if you do not know the answer, you should say so and then proceed to find out as soon as possible. This attitude not only commands the respect of the contractor, but also frequently makes it possible to settle claims with him which might otherwise go to higher authority.

The importance of good relations between the D.O. and the contractor cannot be over-estimated, and these good relations must be founded on a sympathetic understanding of the contractor's difficulties. These difficulties arise chiefly in connection with :—

(*a*) Small scale drawings which require explanation and amplification—before the snags arise—not after.

(*b*) Supervision, when the work is scattered and varied as at Catterick. The contractor is frequently unaware of certain malpractices taking place and it is extremely beneficial to him to have such things put right before they have gone so far as to require expensive alterations.

(*c*) Alterations to plans which are frequently inevitable and are allowed for in the contract. They are nevertheless a source of much trouble and expense to the contractor, and the effect can be mollified to a certain extent by foresight on the part of the D.O., not only in foreseeing possible alterations but also by ordering them in groups to facilitate supervision, instead of piece-meal.

(*d*) Labour difficulties due to the more independent attitude of labour nowadays, which will be touched on later in the article.

(*e*) Supply of R.E. stores which may hold up the work, particularly in the case of such articles as cooking ranges which have to be built in.

It is an excellent plan to hold conferences about once a fortnight between the contractor's agent, and his surveyor if he thinks fit, and the D.O. with his assistant D.O's. if any, and I.W., to talk over affairs in a friendly spirit. Of course, any decision reached must be reduced to writing. Controversial matters requiring a lot of investigation cannot be adequately dealt with and sudden decisions on such matters must be guarded against, but a vast amount of useful work can be done. The contractor can bring up future difficulties he anticipates, and can explain his programme and the priority he desires in R.E. stores. You can explain your difficulties and show the contractor what you are doing to help him. A great deal can be done by word of mouth which cannot be done in writing. As the contract nears completion, it is probably advisable to abandon the regular conference, as any point arising then requires immediate attention.

Before leaving the question of the dealings between the contractor and the D.O., a few remarks on the all-important question of claims are appropriate. In these days of keen competition many contractors look to their claims to give them a profit, and it is necessary to look at such claims sympathetically. It is a great advantage to get claims settled early, so that the financial situation is not obscured by them; they should never be shelved when they arise; hence again we see the necessity of keeping ahead of your work, so as to be able to deal with them as soon as they come to light. It is also a tremendous advantage for you to be able to deal with them yourself, for the following reasons: it accelerates a settlement, it is less trouble because the labour entailed in putting up a case to higher authority is very considerable, and it increases your influence over the contractor. Even if the claim is such that you cannot settle it, you should endeavour to agree with contractor, without prejudice, as to what the reasonable settlement should be, and send up your recommendations with the case. The first thing to consider is whether a claim is reasonable or not; reasonable claims are those arising from extra work necessarily performed, or from difficulties encountered which could not reasonably be expected when tendering; or they may arise from difficulties which have been quite inadvertently created by the supervising staff. Claims which cannot be considered at all are those arising from difficulties which the contractor should have allowed for in tendering and those due to extra work necessitated by his mistake or faulty workmanship. If extra work done inadvertently is clearly a benefit to the undertaking it should, if funds allow, be paid for as an extra. The settlement of claims does not always entail money; there are always small omissions by the contractor or departures from specifications which are not worth putting right, and these may be used to balance against small claims by the contractor Compromises generally should be avoided in settlements; either the claim is allowed and should be

paid for in full, or it is not allowed and should be entirely rejected. To offer to pay a small proportion of an unreasonable claim encourages the contractor to go on claiming, and causes endless trouble. Measuring should not be regarded as a panacea in settling claims, when the amounts involved are small it saves expense and trouble to agree "star" prices, or, better still, balance them up against something else. So much depends on the relation between the contractor and the D.O.; if you have encouraged the contractor to chat amicably about his difficulties from the start and shown yourself sympathetic but just, claims will be few and simple to deal with. If the contractor regards you solely as the man who stands between him and his fortune, claims will be large, numerous, and acrimonious.

Now for a few remarks about the opposing armies. On our side we have surveyors, draughtsmen, clerks of works. In very small jobs, of course, these three may be one, in the person of the M.F.W., and you obtain what you seldom get otherwise—perfect co-operation of the three departments. Though the functions of the three groups appear superficially to be distinct, in actual fact they all overlap on the question of details of design and friction may develop as a result. Smooth working can only be assured by the adequate supervision of their work, not to cramp their initiative but to give them just what guidance they need to obtain uniformity of effort and to ensure that no avoidable obstacles are left in the path of any of them. The secret of developing intelligent initiative is to keep everybody informed of what is going on, and to avoid water-tight compartments above all things.

The clerk of works is one of the most important units of your army; a really good man is worth his weight in gold; an inefficient man is worse than nobody at all. We cannot consider the clerk of works without at the same time looking at his opposite number, the builder's foreman. The latter is almost always a man with life-long experience of his job and may be of two types—the old foreman who has worked for years for his firm and has its reputation at heart, and owes his position mainly to his good work; this, I believe to be a somewhat rare type and is only to be found with the better-class firms; or he may be of the go-ahead type who generally flits from firm to firm, and builds his reputation on getting the work done fast and cheap. This latter type is by far the more common and the more difficult to deal with. It follows that a successful clerk of works must be on the top of the builders' foremen; he must have a better knowledge of the building trade; he must have more determination and he should be a man of better education. The clerk of works may be either a military or civilian. Hard though it may seem to say so, in the light of recent experience, it appears that the civilian is much more suitable for the job than the military man. The latter usually lacks in the essential foundations of wide practical experience in the building trade, and this puts him at once in a position of in-

feriority to the contractor's foreman, unless he has had more than the normal experience of new services and good trade qualifications to start with. On normal maintenance jobs, a military foreman of works puts in too much time in office work to get the full benefit of practical experience. He has the further great disadvantage of being liable to be posted elsewhere at any time, a practice which results in considerable financial gain to the contractor and untold worry to the supervising officer. On the other hand, work of this nature is a first-rate experience for a young M.F.W., and for that reason their appointment should not be discouraged, but they should be so employed that their work can be easily taken over by someone else; generally, they require more supervision than a good civilian. A civilian clerk of works is naturally a somewhat unknown factor and considerable discretion is required in taking one on; he may be an ex-M.F.W., or he may have purely civilian experience. He should have unquestionable character references; he should not be too old—generally fifty is about the limit; he should be of superior education, possess personality and not be super-self-confident. In other words, if he is to be a success you must like the look of him. Technically, he will probably be able to produce references attributing to him a detailed knowledge of every kind of building work, but be sure he can use a level. That is about as far as you can go in testing an applicant, and at a big job where several clerks of works are employed, you are sure to get a mixed team; the first essential is to get to know their characteristics and capabilities, and to post them according to what you know of the various builder's foremen.

In your dealings with them, and this applies to both clasess, remember that they have to work under certain peculiar disadvantages; the military man has his military duties and drawbacks, and a civilian suffers from the lowness of his pay. Probably he is getting about half the pay of the contractor's foreman, and this makes his life more difficult than might appear, if local society is somewhat restricted. It is, therefore, essential to do all you can to increase their prestige and generally to make things easier for them. Give as many instructions to the contractor's foreman as possible through your clerk of works and insist on his instructions being carried out. Ask his advice on how to solve various problems and if you do not like his proposals explain exactly why. Do not go round the work and criticize without him, or you may find yourself condemning some harmless pet theory of his about minor details; "the best is often the enemy of the good," and it is well to admit the existence of more than one reasonable method of doing things. Of course, obvious mistakes and malpractices should be stopped at any time, but that is a different matter. Let him know that you expect him to know everything that happens in his area and if you can see anything going amiss, ask him why he has not spotted it. Do not keep asking him for written reports, and above all, let him know exactly where

he stands. The question of how much you can leave to him depends entirely on the man; for his good and yours you should trust him to his full capability. A difficult position arises when your clerk of works makes a decision which you do not wish to uphold; cancel it if you must, but remember the harm you thereby do to your man's position, and explain your reasons to him and the contractor; if the latter has done work in consequence of the decision before you cancelled it, he must be paid for it. Should a clerk of works be given to making unauthorized decisions, or even to be too hostile to the contractor, the situation may be improved by giving him more work to do. Some can only work satisfactorily when working at full pressure. The main point is that you cannot expect to get exactly the men you want; you must work them as a team in the positions for which they are best suited and your control must be elastic under the broad standards of quality and workmanship which you consider suitable. It should be impressed on all clerks of works that their job is to prevent bad work, rather than to condemn it when done. They should, of course, receive early copies of deviation drawings and orders and see that they are not overlooked by the contractor; in other words, they are to help the contractor, not to fight him. In particular, they must be tactful in dealing with the contractor's men, owing to the more independent attitude of labour. The commonest complaint of the contractor against the clerk of works is that he interferes with the men, and it is a most difficult complaint to deal with. In theory, the clerk of works should act solely through the builder's foreman; in practice, this is impossible on scattered works at any rate; his conduct should be a mean between the two extremes—he should deal with the general foreman, sub-foreman or charge-hands, wherever possible, and with the men only as a last resort, when things are going irrevocably badly and no foreman is present. A clerk of works who has recently been a builder's foreman is particularly useful by reason of his inside knowledge, but also is specially apt to deal with the men direct. It is a very difficult question and apt to give rise to serious trouble but, like many other things, it is more often the occasion than the cause of dispute, and if the clerk of works has established helpful relations with the builder's foreman the latter is unlikely to raise trouble on this score.

The thorny question of how much work one clerk of works can supervise has no answer; there is no standard either in money or area, or extent of works by which the staff required can be fixed; comparisons between works in different stations are valueless, unless conditions are precisely the same, and among these conditions is the efficiency or otherwise of the contractor; this much only can be said —an officer can hardly supervise efficiently the work of more than four clerks of works, and it is generally better to keep to this figure, at the expense of working the men rather hard, in preference to employing more, unless an additional officer is available.

Another important duty of the D.O. is to keep the financial situation clear and up-to-date, in order to avoid running short of money on the one hand, or having an unwanted surplus on the other which might have been usefully expended in the work. Uncertainty in regard to the financial situation is a constant source of anxiety and sometimes results in economies being needlessly carried beyond the limit of efficiency. Assuming a good estimate to start off with, the probable causes of discrepancies are, firstly provisional work, secondly extras, and thirdly claims. Provisional work normally comprises roads, paths, drains, water supply and work below damp-proof courses, and a roughly estimated amount for all of these is allowed in the bills, subject, of course, to final measurement. There is bound to be some uncertainty about it, but the situation can be usefully improved by the early preparation of accurate drawings for external services worked out on the ground; such drawings not only enable a closer estimate to be made, but they prevent mistakes in execution. Alterations to the under-building, such as are entailed, for example, by the substitution of hollow for solid ground floors, should be decided early and a liability worked out.

With regard to extras, the only point to be emphasized is that they must, however small, be covered by proper priced deviation orders and the liabilities recorded. It is extraordinarily easy to neglect this procedure, especially where a number of small alterations are required, and particularly where instructions are given by clerks of works. Most contracts lay down that the contractor must claim within a specified short period for any work done by him without an order; in practice, this is a dead letter. All you can do is to insist on day-work sheets being sent in in reasonable time for checking—they often give a useful indication of extra work which should be covered by an order and measured.

Regarding claims, the importance of early settlement has already been urged. It is sometimes expedient to keep a definite reserve in hand to deal with possible claims, and if this is done, cut and dried schemes for spending that money at the very end of the contract should be prepared so that if the claims fail to materialize, the money can still be usefully expended.

The close control of finance if practised from the outset is not a laborious business and of first importance in economical administration.

In conclusion, it may perhaps be said that some remarks on technical difficulties and experience would have formed a more valuable contribution than the foregoing article on administration, but I maintain that this is not so. A sound system of administration should give a D.O. time to find out the technical details he requires, to use the experience of others, and, finally, to season the information he gets with the salt of commonsense before translating it into practice.

JOTTINGS FROM A FIELD COMPANY ON MANŒUVRES.

By "GEEKAY."

ALTHOUGH the following useful and instructive lessons were learnt by this Field Company on Manœuvres last year, it cannot be pretended that there is anything very novel in them for many officers. Yet to some they may be new, and to others they may be of value in promoting discussion. This, then, is the excuse for these notes.

1. INTER-COMMUNICATION.

This proved a great difficulty at first. A Company, especially when in a Brigade Group, is bound to be in several detachments. For instance, in an approach march with an Infantry Brigade, there would certainly be (*a*) the O.C. with Brigade H.Q., (*b*) a reconnaissance party with the vanguard, (*c*) the main body, (*d*) "B" echelon first-line transport; probably also (*e*) an advanced section with the main guard. In attack, defence, and especially in a retirement, detachments are practically inevitable, while the distances between them may be considerable.

Though means of inter-communication, viz., motor and pedal cycles, are provided within the Company, it is felt that they should only be used for short distances or on particularly important occasions and that, as far as possible, the services provided by the Royal Corps of Signals should be utilized. To enable this to be done, the organization must approximate to the system of the Royal Signals and facilitate the establishment of report centres.

It was accordingly arranged, in conjunction with Signals, that each sub-unit should be prepared to find a report centre, which was given a code name, and that when the sub-unit was detached, it should keep its report centre in touch with a Battalion or Artillery Brigade H.Q., and use, as far as possible, the Signal Service it found there. It was to keep the cyclist orderlies normally for communication from the report centre downwards, and only exceptionally upwards. The organization tried on this occasion was:—

Report Centre.	*Coy. H.Q.*	*Each Half-Coy.*	*Each Section.*
Composition.....	O.C. 1 clerk 1 motor-cyclist 1 orderly Corporal	1 officer or N.C.O. 2 cyclist orderlies	1 N.C.O. 1 cyclist orderly
Code names ...	FINE	FINER FINEL	FINEA FINEB FINEC FINED

NOTE:—The Half Company and Section Report Centres were alternative. For instance, either the Left Half-Company *or* Nos. 3 and 4 Sections, would establish Report Centres according to circumstances.

Instruction was given in writing messages and in using the envelopes in compliance with Signal procedure.

Unfortunately, the system was not fully tested, but from the few occasions which did arise it was evident that it would be of great value as soon as it became an established routine not only in the Field Company, but in the Signals and other troops whose co-operation is necessary. Mechanization, when it comes, involving as it will greater dispersion, will make some such system more imperative.

2. Messing.

Another difficulty which was due to the inevitable detachments was that of feeding the men, particularly the provision of a hot evening meal. It is most unsatisfactory to rely on a Battalion to provide food for an R.E. detachment; with the best will in the world there are many difficulties, and in practice it is essential to rely on one's own resources. The hay-box appeared to be the solution here. On manœuvres, when all too little work requiring R.E. to use tools is met with, there is room for a hay-box suitable for one section in the L.G.S. wagon which accompanies each section. If a section appears likely to be detached during the day, the hay-box can be filled with dinner at breakfast time. If the detachment is made at a time when the cooker is not up, the hay-box belonging to another section can be filled as soon as the cooker comes up, and sent to the detached section on the greatcoat lorry when it arrives.

3. Map-Reading.

The need for plenty of practical map-reading instruction was amply demonstrated. Though N.C.O.s and men may have passed the map-reading tests for the various certificates of education, the map-reading on operations was often at fault. Even young sappers who happen to be "cast" for the duty of cyclist orderly must be at home on the map. Therefore, map-reading instruction must be thorough and practical throughout the Company.

4. Clerk's Duties.

Do we give our clerks sufficient instruction in the duties they would have to perform in the field, *e.g.*, writing orders and messages from dictation, filing messages and field correspondence? Manœuvres provide an excellent opportunity for this. The clerk should also be good at map-reading, as he will prove of great assistance in checking map co-ordinates, etc. Incidentally, if officers practised dictation to clerks in their own offices more, they would find it a method of gaining increased clearness of thought and expression which would repay them well in oral and written examinations.

5. AMMONAL.

Occasions arose when it was necessary (on paper) to crater roads. It was assumed that ammonal would be available from civilian sources —the operations were supposed to be in friendly country—some eight hours after it was demanded. This, however, proved too much for the umpires, who disallowed its use, as no reference to how it would be carried or supplied in war was made in any military book. Considering the unique value of ammonal, and that it is now ten years since the end of the Great War, in which it was so largely used, the decision seemed somewhat hard.

6. NOTICES ON DEMOLITIONS AND WORK DONE.

These, drawn up in the form laid down in *Training and Manœuvre Regulations*, added tremendously to the interest of the unit in the operations. They also provided very useful instruction for all concerned. It is suggested, however, that they require very careful umpiring, and that the forms might be issued in pads, so that three copies might be taken at a time with carbon paper; one copy to be put up at the site of the work, one copy for the umpire staff, and one copy for the Company commander to check over later for instructional purposes. In addition, the space allotted for the umpire's signature might be reduced and the printing re-arranged so as to give more room for sketches and details of the job.

As said before, careful umpiring is important. This is evidenced by the tendency of columns of All Arms to advance, often without a R.E. reconnaissance party well forward, and even more often without any R.E. working party further forward than the tail of the main body. An occasional tree felled across the road would bring the lesson home in a remarkable manner. Could not this be arranged?

7. MECHANIZATION.

By a fortunate chance it was found possible to hire privately two 14-cwt. Bean drop-sided lorries for the four days of the final manœuvres. The underlying idea was to see how even a small amount of mechanization might improve the efficiency of a Field Company, both from the point of view of capacity for work and of administration. The result, though the operations did not provide much of a test for the experiment, far exceeded the anticipation. Each lorry could take a section (peace strength) and enough tools for the job in view. It could travel up to 40 miles an hour on roads, and proved most reliable even though the drivers, who were found from the unit, were fairly inexperienced in lorry driving.

The use of these lorries in facilitating work was well shown on one occasion, when the Company was marching at the tail of a Brigade Group advancing. Within half an hour of the O.C. receiving, from the Brigadier at the head of the main body, the order to block against

armoured cars the side roads opening on to the route, one section had reached the advanced guard and begun blocking the side roads. The lorry dropped detachments for the work at each point, and picked them up later. In this way it again soon caught up the main guard and was in a position to block roads as soon as the latter reached them.

On another occasion, reconnaissances for erecting a medium bridge over a river on a front of 2½ miles were required. By means of the lorry, which carried sufficient personnel and bicycles to make four reconnaissance parties, the reconnaissances were made, and the parties back at the Infantry Brigade H.Q., with complete reports within 2½ hours from the time they left that H.Q., which was four miles from the river at the nearest point, and 13 miles from the Company when the order to make the reconnaissances was given.

Again, an Infantry Brigade which was to have been embussed would have had two sections R.E. in M.T. up with it to clear roads blocking its advance and to protect its isolated flank as it worked forward " into the blue " to forestall the enemy on a " key " position.

These instances appear sufficiently convincing, though fate prevented the fulfilment of sensational dreams, such as using the M.T. to forestall, with an anti-tank minefield, a tank attack reported by air as being imminent, or surprising the enemy by constructing rapidly, with men unwearied by marching, a medium bridge at a considerable distance from where the enemy had located the Bridging Train.

On the administrative side, circumstances prevented the lorries from getting much scope, but how invaluable they would have proved in supplying food, greatcoats, bivouacs, etc., to, and replacing expended explosives with detached sections could easily be imagined after our experiences in the previous minor operations. As it was, they returned the Company quietly and comfortably to camp, 17 miles from its position at the " cease fire," in less than five hours, the men having all had a meal on the way.

The expenditure on the two lorries, apart from hire, which included the services of a civilian fitter to get our inexperience out of possible difficulties, amounted to £9 5s. 3d., but of this, £6 was due to arranging insurance against third party risks. This had to be done at very short notice, and surprising difficulties were raised by the insurance companies. A far cheaper rate could almost certainly have been obtained if the insurance had been effected earlier. The lorries between them covered 500 miles in the four days, and used 40 gallons of petrol.

To say that the lorries provided an interesting experiment is to say little—they turned what would have been a prosaic and rather wearisome four days into an intensely interesting, thrilling and by no means uncomfortable climax to our collective training.

We in this unit have no lingering doubts as to the desirability of mechanization as far as a Field Company, R.E., is concerned.

THE USE OF POWER TOOLS IN A FIELD COMPANY, R.E.

By LIEUTENANT L. T. GROVE, R.E.

IT has long been suggested that more use should be made of power tools in a Field Company, and the subject is an interesting one, though it is easy to exaggerate the possibilities of the use of power in the forward areas. At one time, suggestions were made that there should be a kind of mechanical elephant with each section, that should be able to do such things as pile driving, concrete mixing, excavating and other duties, but it is now generally agreed that a combination machine of this type would be very unsatisfactory.

A clear line should be drawn between the work that a Field Company may have to do at a moment's notice and the more deliberate work for which there will be time to send up special appliances from R.E. Parks. Pile drivers, concrete mixers and excavating machines all fall under the latter heading, and although R.E. units should be trained in their use, there can be no excuse for attempting to carry such plant as part of the equipment of a field unit. Their place is in the R.E. Parks, and they can then be sent up when required.

There are, however, many applications of the use of power which are of the greatest value to a field unit for work which they may have to carry out immediately, without waiting for tools or equipment to be sent up to them. The most obvious of these are the use of a compressor plant and a winding gear driven from a lorry engine; the latter can be used in combination with a sheer legs mounted on the rear of the lorry. Both these appliances have been used by the 17th (Field) Company during training in 1928, and a brief account of the work which they can carry out may be of interest.

COMPRESSOR PLANT.

Description of Plant.—In the spring of 1928, the 17th (Field) Company were sent a Reavell portable air-compressor for trial with various types of pneumatic tools. This machine is almost precisely similar to those used for road-breaking on a large scale, such as may often be seen in London or elsewhere, the only modifications being that pneumatic tyres and a stronger draw-bar have been fitted. The machine is thus able to be towed, across country if necessary, by a six-wheeled lorry. To give a detailed description of its mechanism is quite outside the scope of this article. It is sufficient to say that

it consists of a petrol engine direct-coupled to the air-compressor. Besides the ordinary ball type governor there is an automatic cut-out which regulates the air pressure between 75 and 100 lb. per sq. inch. Thus, once the machine is started, practically no supervision is required, and it is quite unnecessary to carry a special mechanic to look after it. Very little maintenance work is required either, and as the engine runs on grade III petrol similar to that used by the company M.T., there is no difficulty about fuel supply in the field.

Tools.—Three types of pneumatic tools have so far been tried :—

(1) *Concrete Breaker.*—This is the tool normally used for breaking up a hard road surface. The body of the tool consists of a barrel, inside which works a piston driven by compressed air and delivering a series of hammer blows to a steel pick about two feet long. It is a heavy tool, weighing about 70 lb., and for that reason its main uses are confined to breaking up horizontal surfaces such as roads, concrete floors, etc., where the operator can put his full weight on the handle. It is therefore especially useful for such purposes as digging a trench across a road to form an armoured car obstacle ; digging down through the metalling of a road to place a mined charge for blowing craters or to get at the crown of a bridge ; digging out girders which have been set in concrete, etc.

(2) *Pneumatic Pick.*—This is a smaller tool working on the same principle as (1). Its weight is only 16 lb., so that it can be worked one-handed if necessary, and is generally used against walls, abutments or piers, and for getting into awkward corners which the larger tool cannot reach. Naturally, it has not the same shattering power as the concrete breaker, but it is quite effective for cutting into brickwork or soft masonry.

(3) *Pneumatic Drill.*—This is a tool similar in size to (2), but works on a rather different principle, combining both " hit " and " twist." With each stroke of the piston, the shank of the drill rotates, thus producing the effect of a hammer drill. It can be used against rock, concrete or brickwork, and produces a bore hole 1½ inches in diameter, at an average speed (in concrete) of two feet per minute. The rate of working in other hard substances does not vary much, but the tool is useless in a soft or sticky material, such as wet chalk or clay. The value of this where a cutting charge is required for a hasty demolition is considerable, as it enables a row of bore holes two or three feet deep to be cut in a very short time. These can then be filled with any explosive made up in a suitable form, such as dynamite sticks, tubes of ammonal, or even a tin of G.C. primers, and the whole charge is very quickly laid and very economical in explosives. In this connection it might be worth considering the supply in stick form of a proportion of the wet G.C. carried by a Field Company.

Results of tests.—In order to obtain a somewhat clearer idea of the possibilities of such an air-compressor in the field, a number of tests have been carried out with a view to estimating the time saved as compared with the ordinary methods. The results of these tests are tabulated below :—

Nature of task.	*Men employed by each method.*	*Time taken, using compressor and pneumatic tools.*	*Time, using picks, shovels, hammers, chisels, etc.*
1. Digging a trench 2 feet wide and 13 feet long in a first class tar macadam road.	6	35 minutes per foot deep.	1½ hours per foot deep.
2. Cutting a hole 9″ x 12″ in ordinary concrete.	2	10″ in 17 minutes.	3″ in 25 minutes.
3. Ditto in brickwork.	2	9″ in 15 minutes.	9″ in 75 minutes.
4. 1¼″ borehole in concrete.	1	2 feet per minute.	—
5. Sinking a hole 1′ x 1′ in the middle of a macadam road, suitable for a mined charge, and for cratering.	2	15 minutes per foot down to a depth of 5 feet.	—

These tests were selected as typical of the sort of work which a Field Company might be called upon to do at a moment's notice in mobile warfare. 1. provides an effective armoured car obstacle in the sort of country where material for making road blocks is scarce. 2., 3. and 4. are suitable methods of laying a charge for the hasty demolition of piers, abutments or retaining walls, as they enable a big effect to be produced with quite a small charge. 5. is perhaps the quickest method we have at present of laying the charge for a road crater. It will be seen from this comparison that the rate of working, using the compressor plant, is about three to five times that obtained by ordinary methods, besides which, some of the results achieved are practically impossible without special tools. Experiments are also being carried out with a type of three-pronged fork, adapted for use with the concrete breaker, for digging in ordinary soil with a view to assisting rapid excavation in the forward areas. So far, not sufficient trials have been made to form any definite conclusions on this subject.

Besides these tests, an actual demolition of a masonry pier was carried out. The pier was constructed with a 9″ brick retaining wall, filled with chalk and rubble, its dimensions being 12′ x 6′ x 8′ high. Thus, using the ordinary formula ($\frac{2}{3}$ BT²) for a cutting charge against masonry, 288 lb. of G.C. would have been required. By means of the pneumatic picks, two holes 9″ x 12″ were cut into the centre of the pier, 3′ from each end. Then, treating it as a mined charge, it was found that 5 lb. in each hole would be sufficient. As a precaution this charge was doubled, so that 20 lb. were actually used as against 288 lb. by the other method. The total time taken to place the charge, connect up, and tamp, was under 45 minutes. More-

over, owing to defective F.I.D. only one charge actually went off, but this alone was sufficient to cut the whole pier right through, and produce a complete demolition.

The chief difficulty so far encountered has been presented by reinforced concrete. None of the standard pneumatic tools can cut through the steel reinforcement, and we have got to find a special tool for the purpose. An experimental type, in the form of a punch, has just been designed, but it has not yet been tried out. When a suitable tool has been found it will become an essential part of the equipment, owing to the particular suitability of concrete work for demolition in this manner.

Owing to the nature of the work it was, of course, impossible to carry out practical trials with the compressor plant on manœuvres. Cases were, however, continually arising where it would have been of the greatest value, and its use was assumed in dealing with the situation.

Such cases may be mentioned as armoured car obstacles, bridge demolitions, craters in fords, etc., which, with an armoured force in the field, are of primary importance and have to be carried out often at a moment's notice. Generally speaking, the experiences of the manœuvres combined with the results of the practical tests described have shown that a compressor plant would be of great value to a Field Company in mobile war, and more particularly so when armoured fighting vehicles are involved.

Winding Gear.

The present proposal is that the tool lorry in each section should be fitted with winding gear and sheers. The method of carrying the tool boxes and sheer legs can be gathered from the accompanying photographs. The winding gear is a standard fitting and forms part of the gear box. It is engaged by a special dog clutch and fitted with a band brake for paying out slowly, or holding the load. The winding drum is geared at 68 to 1, with the gear lever in first speed, and with the engine running at 1,000 revs./min. the lineal speed of the rope is 44 feet per minute. (This figure is an average; actually it is higher when the drum is full and lower when the drum is empty.) The drum carries 96 feet of $1\frac{3}{4}$" special extra flexible steel-wire rope.

The sheer legs are fixed to the rear of the lorry chassis, the top of the legs being $10\frac{1}{2}$ feet above the ground and overhanging two feet beyond the tail of the lorry. The wire rope can be used for horizontal hauling, being guided out between rollers on the rear of the lorry, or it can be taken over a pulley on the top of the sheer legs. A special frame and sprags are provided. These are carried on the lorry and can be fixed in a few seconds. They serve the double purpose of anchoring the lorry and of supporting the main frame at the point of

attachment of the sheer legs, so as not to transfer the vertical stresses through the axle springs on to the ground. These sprags can be seen in use under the sheer legs in photograph No. 2.

The winding gear in conjunction with the sheer legs can be used in three ways, to suit different purposes :—

(1) The sheers can be used without sprags for lifting and carrying loads up to 15 cwt. Over this weight the front wheels of the lorry then tend to come off the ground, the whole chassis pivoting about the rear axle. With this load the frame is stressed up to eight tons per square inch. The maximum lift obtainable is nine feet from the ground to the shackle at its highest point.

(2) By using the sprags and sprag frame, the sheer legs can be used for any pull from horizontal to vertical. The limiting horizontal stress is 2 tons, after which the front of the lorry tends to lift as before, though pivoting now about the sprag frame. By weighting the front of the lorry this can be increased to 2½ tons.

(3) For horizontal pulling without using the sheer legs, three tons can be obtained comfortably. There is now no tendency to tip the lorry, but the sprag frame must be securely spiked to the ground or the whole thing will be pulled backwards.

The winding gear and sheer legs are in constant use for many purposes. They are very handy for shifting heavy girders or box sections so as to save manual labour, and demonstrations have been given to prove their value for this purpose. In photograph No. 1 the lorry is shown carrying a box girder section weighing 13½ cwt. The speed of the lorry in such cases is limited to about three or four miles an hour, and over rough country it is advisable to have a couple of men handy to steady the load from swinging too much and so damaging the sheer legs. Even with the limited scope imposed by peace conditions on R.E. work in manœuvres, some use was found for the sheer legs. For instance, gateposts have usually to be removed before tanks can enter a bivouac area, and whereas this is a tedious process by digging, they come out like corks under the sheers. Then again, the shore transoms on a heavy bridge have to be securely picketed down, and when the bridge is picked up these pickets have to be pulled up as well. This can be done in a few seconds by using the sheers. They are equally effective for removing picket holdfasts, etc. A further use is shown in photograph No. 2, where the lorry is launching a 30-foot tank bridge by means of the sheer legs. Attempts to erect an actual road block on manœuvres to be removed by the winding gear did not materialize, but this will

o. 1. Carrying a heavy box girder section (13 cwt.).

Carrying a Heavy Box Girder

Launching a 30ft Tank Bridge

be tried shortly. Generally speaking, the winding gear and sheer legs have proved their worth. They only add a small weight to the lorry, and the sheer legs have never been found to get in the way. In any case, it only takes a moment to lower them to pass under a low doorway or for any other purpose.

The maximum pull obtainable with this equipment—three tons—is insufficient for many purposes, and a scheme is being tried to produce a more powerful type altogether. Briefly, the intention is to mount a similar type of sheers 20 feet high on a Guy medium 6-wheeler chassis. The sheer legs will be made to fold forward so as to enable the lorry to pass under bridges, etc., and will be erected when required. A five-ton pull will then be available, and the lorry will be able to launch the heaviest types of box girders, etc., now in use, thus eliminating all necessity for holdfasts, standing derrick, etc., which at present take up so much of the time.

In addition to these trials, we have experimented with a circular saw, driven off the lorry engine of a medium 6-wheel lorry. The saw is mounted across the lorry, and it takes up very little space. To drive the saw, the Carden shaft is removed and a chain pinion fixed behind the gear box, and the drive taken by chain to the saw spindle. This operation takes about ten minutes, and the saw is then ready to rip up anything up to 12" x 12" timber.

As regards the transport for these power tools and devices in the field, it seems fairly clear that each section should have its light lorry with winding gear and sheer legs; the heavier sheer legs on a medium lorry—if it proves successful—and the saw would both be very useful in a Field Company, but may find their way back to the Field Park Company. The compressor plant would also be very useful in each section, but will no doubt have to make a start at Company Headquarters only, and the same probably applies to other devices, such as power pumps and acetylene cutting plant. These and many other points connected with this subject will, no doubt, be settled in due course as we collect more knowledge and experience in this direction.

A FIELD COMPANY IN MALABAR.

By "ASSAYE LINES."

IN August, 1921, the seditious teaching and the anti-British agitation, which were so marked a feature of Indian politics at the end of the War, culminated in a rising of considerable magnitude in Southern India among the fanatical Mahommedan inhabitants of the Malabar Coast. The Moplahs have always been known to be an extremely inflammable race, liable at any time to sudden outbursts of violence against the unbeliever, either Hindu or Christian, but in the past these outbursts had only had an individual significance and had seldom shown any signs of organization or been marked by any political features. The latest outbreak was, however, of quite a different character, and was the result of political and religious propaganda acting upon the minds of an uneducated and fanatical people; it took the form of an organized rebellion against British rule, and foresaw the formation of an independent Khilafat kingdom, which was to be the forerunner either of Indian Swaraj or of a new Mahommedan Empire, depending upon the individual religion and ambition of those who had schemed to bring it about.

When matters finally came to a head, the district (comprising an area of about 1,500 square miles, lying between the Nilgiris and the sea) was rapidly overrun by the rebels, and the responsibility for protecting the large European population of Calicut, as well as the large number of planters and police posts scattered throughout the area, was thrown upon the shoulders of the small British garrison at Calicut, which consisted only of a company and a half of infantry. The country is an extremely difficult one owing to the prevalence of close jungle and impassable rice-fields, and to add to the difficulties, the rebels at once cut the railway line linking the Malabar coast with the rest of India; they also blocked the roads, which are generally good, by felling trees across them and destroying numerous bridges, while the situation was further complicated by the fact that a small detachment of the garrison was cut off in Malapuram, an important village near the centre of the disturbance, where it had been necessary to send them shortly before the commencement of the outbreak.

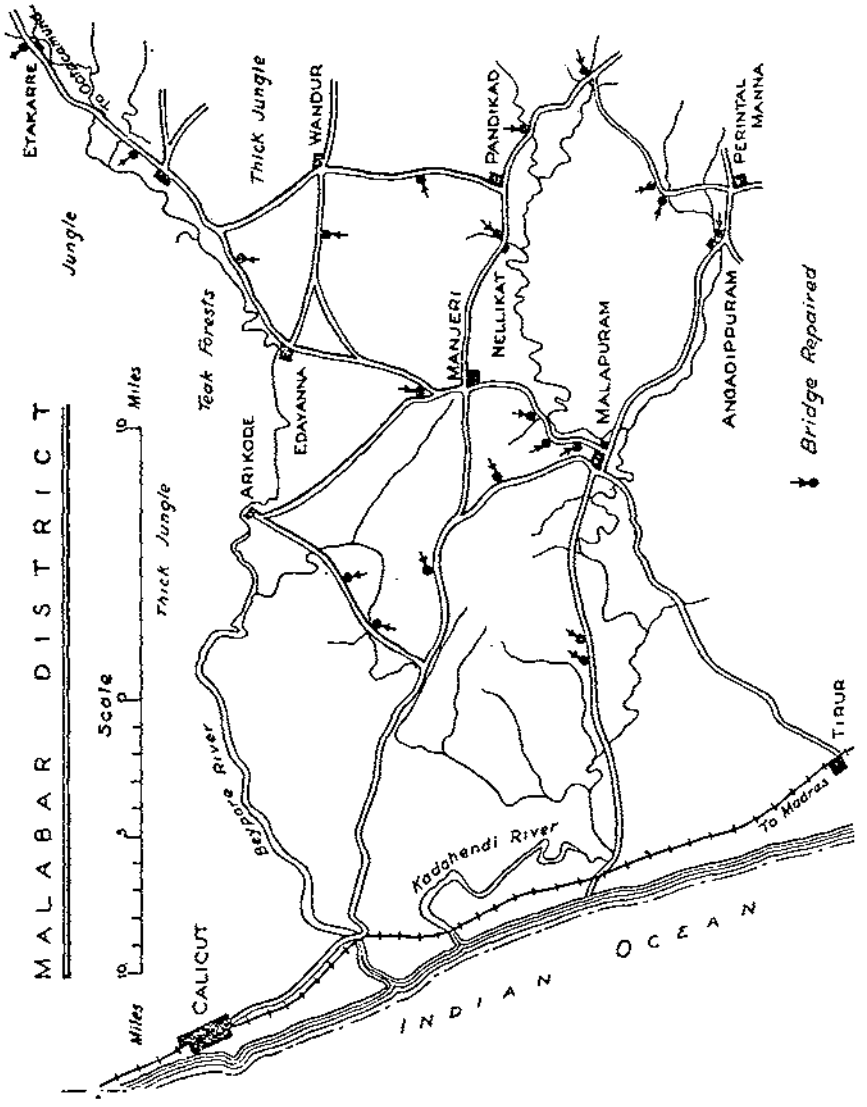
On receipt of the news of the rising, two movable columns were mobilized at Bangalore, and were dispatched by train to the disturbed area, the whole force amounting to about 1 battalion of infantry, 1

troop of cavalry, 2 sections R.F.A. 2 platoons* of Sappers and Miners, and 1 company of pioneers. The railway to Calicut was quickly repaired, with the aid of the Sappers and Miners, Malapuram was relieved by the columns working north from the railway near Shoranur, and with the passing of the immediate crisis there began the first phase of the operations designed to overcome the power of the rebels and re-establish law and order throughout the area. The conduct of these operations was largely determined by a difficulty inherent in all warfare against a savage enemy, that of the lack of an objective, as the rebel bands, well served in the way of intelligence, were able to concentrate or disperse at will, and could find a safe refuge in the depths of the forests or in the hilly jungles where the troops could not follow. The procedure adopted was that of sending small columns to traverse the affected area, with the double purpose of "showing the flag" and of forcing an action in the event of any considerable body of the rebels being met; and, as these columns had of necessity to be self-supporting for considerable periods, a great deal of "first-line" sapper work was entailed in order to allow cart transport to accompany them. The Malabar coast is a country of heavy seasonal rains, and the Moplahs from the first had shown considerable zeal in destroying the numerous road bridges; over the greater part of the area the roads were closely lined with thick jungle, which offered extremely favourable opportunities for ambush, and made it easy for the rebels to impede movement by felling trees or large clumps of bamboo across the roads; as a result it was essential to have a proportion of sappers with each column which was sent out, not to maintain communication between the column and its base, which would have required more men than were available, but to allow the column to move at all and to return when its task was completed.

As there was practically no local supply of material suitable for bridging purposes, most of the work done was of a very temporary character, except in those cases where the damage was less serious and could be repaired. A certain bridge was built by friendly Moplahs during this period, and was strengthened by a platoon of Sappers and Miners to enable it to take a 30-cwt. lorry. The brick arch which had been destroyed by the rebels had a clear span of 27 feet, and the local design consisted of two outer trestles, each of which was made up of three small tree trunks, cut with a fork at the top to carry the transom, and without any attempt at ledgers, trestle diagonals, or struts. The road-bearers were nine-inch spars cut near the site, and the roadway consisted of split bamboo and areca nut trees tied down with thin coir rope; although the effect was reminiscent of Heath Robinson, the bridge was still standing after a column, accompanied by cart transport, had passed over it. The sappers, working against

* Now "sections."

time, strengthened the bridge as originally constructed by the addition of the central trestle and of diagonals and struts, while the roadway was improved by adding another layer of decking, consisting of 1½-inch planking obtained from the doors and partitions of neigh-



bouring houses. Another piece of temporary bridging, which was carried out by a platoon accompanying a column and carrying practically only its first-line equipment, was the construction of a 70-foot timber trestle bridge to take 30 cwt. lorries. In this case, a certain amount of squared timber was available in the vicinity in the shape of

door frames, wall plates, floor joists, etc., although it had to be collected by bullock *bandy* from scattered villages anything up to five miles distant, and in spite of the fact that the road had to be diverted, the bridge was completed and opened to traffic after two days' work. Unfortunately, this bridge was raided and destroyed by the rebels before a photograph was taken of it, but it formed a very good example of emergency work carried out under great difficulties in the way of time and material. The work of the sappers during this period was not confined to bridging, but included the clearing of roads, the crossing of a broad fast-running river by night by means of a flying ferry, the construction of a corduroy road for 18-pdrs. up the steep, jungle-covered slopes of a hill, as well as a certain amount of work in connection with camp defences. The best example of a road block consisted of two large bamboo clumps each about fifteen feet thick, and of ten teak logs of an average size of two feet by two feet by 35 feet; the bamboo clumps could not be dragged aside owing to the thickness of the jungle, and the logs, which had been hauled into position by captured Government elephants, were much too heavy to move quickly. Fortunately the column was accompanied by fifty coolies who had been provided with billhooks, and, with their assistance, one platoon of sappers and one platoon of pioneers cleared the road in fifty minutes by cutting through the bamboo and by sawing and dragging aside the teak logs.

After a short time, the employment of small mobile columns working from a common centre was found to produce little result, and, as more troops became available, the operations entered upon a second phase, in which a system of garrisoning was adopted, small bodies of troops being posted in all the more important villages, and each garrison being made responsible for a definite area in which it worked. The rationing of these outlying posts was carried out by means of motor and cart convoys, which made imperative good road communications throughout the district, and, finally, the arrival of large reinforcements, including a battery of armoured cars reputed to have a live back-axle load of six tons, made the semi-permanent repair of all road bridges essential. The two Sapper and Miner platoons which had accompanied the original movable columns, and which had only carried their first-line equipment, were replaced by a complete Field Company, and steps were taken to organize the work and provide for the supply of all bridging materials required. The officer of the P.W.D. in whose district the rising had taken place was appointed Executive Engineer to the force, and was made responsible for the supply of material and also for the ultimate design of the bridges to be repaired, as it was decided to bear in mind as far as possible future civil requirements, although the actual construction and the question of priority of work remained of necessity in the hands of the military commander. Squared timber of various sizes was

obtained in large quantities from Calicut, which is the port of outlet for an important timber producing area ; stores such as spikes, dogs, telegraph wire, nails, etc., were collected, and extra engineering tools which were likely to be useful were borrowed from the P.W.D. These tools included extra blocks and tackles, rope, carpenters' tools and, most useful of all, two six-ton jacks. The timber and other stores were conveyed from railhead at Tirur to a central dump at Malapuram, and arrangements were made for the engineer reconnaissance to be carried out of those bridges whose details were not already known.

During a period of about three months, twenty-five bridges of spans from twelve feet upwards were either repaired or strengthened to take the armoured car load, the work carried out varying from the construction of a 70-foot timber trestle bridge (in place of the temporary bridge referred to previously) to the replacing of steel roadbearers on the original seating and the provision of new decking. In addition to this bridging work, a certain amount of work was done in the way of road maintenance and improving camping facilities, while all important isolated bridges were protected by a small blockhouse surrounded by barbed wire, and designed for an infantry garrison of about ten men. The most important type of this miscellaneous work was, however, that carried out in connection with camp defences. The fanatical nature of the rebels and their extremely good intelligence service and knowledge of local geography made it essential that all camps should be of the close perimeter type, and that they should be protected by as stout an obstacle as possible. The importance of this was recognized early, but it was brought home in earnest when a small post in Pandikad was attacked by the Moplahs, who succeeded in getting inside the defences and caused severe casualties before they could be accounted for. The post was rushed at dawn by a band of about 2,000 rebels, and the laterite brick wall which took the place of an obstacle was overturned by the sheer weight of the rush; the impetus carried the leaders of the attack inside the perimeter, and it was only the enfilade fire of two machine-guns, sited to fire along the line of the obstacle, which saved the situation. The type of obstacle which was most commonly employed is referred to in the following notes, which it is hoped may be of interest.

I. BRIDGING.

(*a*) *Materials.*—The most useful size of timber supplied was 12′ x 9″ x 3″, and was used for decking, cribwork, trestles, and on one occasion for roadbearers, its value being greatly increased by the fact that it could be carried in case of necessity in army transport carts or in Ford vans. 10″ x 6″ and 10″ x 5″ of various lengths were the stock sizes used as roadbearers, and a certain amount of 12″ x 6″ was reserved for the transoms of two-legged trestles.

600-lb. telegraph wire was used for Spanish windlasses, holdfasts, etc., and 6″ and 9″ spikes were supplied for fastening down the roadway and for the construction of the smaller trestles. 12″, 15″ and 18″ bolts were either supplied or made up for use on the larger trestles and for bolting on all transoms and ledgers.

Suitable material was extremely scarce locally, but was used whenever it was available, chiefly for handrails, longitudinal bracing and for cribwork.

(*b*) *Abutments.*—As a large number of bridges in the area consisted of rolled steel joists carrying either a timber or a metalled roadway, the abutments were the usual places to be attacked, the normal procedure of the rebels being to work at the laterite brickwork with picks and crowbars until the roadbearers dropped into the river. In repairing the abutments, the loose and damaged brickwork was removed until a level seating was obtained, and the abutment was then built up with timber cribwork until the original level was reached. In one case where the abutment had been entirely demolished, it was necessary to erect a shore trestle close up against the unsupported wall of earth.

(*c*) *Trestles.*—A large amount of trestle work was done, as, in addition to repair work, several bridges had to be strengthened to take the armoured car load. Trestles up to 24 feet in height were made up of 9″ x 3″ scantlings, the smaller sizes having two legs of three 9″ x 3″ timbers each, and a 12″ x 6″ transom, the larger sizes having three legs and a 10″ x 6″ transom. The three scantlings making up each leg were bolted together with a three-inch gap between each, which increased the strength of the leg and simplified the bolting or spiking in of transom, ledger and diagonals. Several trestles were made up of local timber, 12″ x 6″ and 10″ x 6″, and in these cases both ledger and transom were let into the legs and bolted through.

(*d*) *Roadbearers.*—Timber roadbearers were used for spans up to fifteen feet, mostly of 10″ x 6″ and 10″ x 5″, although over a ten-foot span 12′ x 9″ x 3″ roadbearers were used on one occasion. R.S.J.s of various sizes and 70 lb. steel rails had been used in the original construction of most of the bridges, and wherever possible these were salved and replaced, although the very small section modulus of the steel rails made them unsuitable for use in spans of any length. Distance pieces were always put in at the abutments and in the centre of the span, and the roadbearers were wired together by Spanish windlasses of telegraph wire.

(*e*) *Roadway.*—12′ x 9″ x 3″ and 8′ x 9″ x 3″ planks were used for the roadway, each plank being spiked down to the roadbearers or to the plank below it. Double decking had to be provided in all cases for use of armoured cars, the bottom layer, which carried the handrails, being laid transverse, and the top layer parallel to the roadbearers.

(*f*) *Bridge No.* 1.—This bridge, which had already been twice repaired for light traffic, consisted of two spans of 27 feet, with a central trestle made up of 70-lb. rails standing in a concrete bed. The roadway had been destroyed, and the roadbearers, three 10″ x 5″ R.S.J.s in each span, had been thrown into the river, but the central trestle was left standing. At the time when the bridge was repaired, the water level was 19 feet below the bottom of the roadbearers, and as the bridge was situated on a sharp curve of the river, the centre of one span had five feet of water below it, while the other span was dry. It was decided to repair the bridge as quickly as possible to take lorry traffic, and to strengthen it later by adding timber trestles in the centre of each of the original spans.

The replacing of the roadbearers and roadway presented no difficulties, and the smaller trestle, which was made up on a sandbank just below the bridge, was brought into position and raised by block and tackle slung from the roadway. Owing to the slope of the abutment walls, however, the span at water level was less than the height of the second trestle (24 feet), and this trestle had to be towed below the bridge with the transom up-stream and raised from that position, instead of the normal method with the legs parallel to the roadbearers. The trestle was made up of 16′ x 9″ x 3″ scantlings, and had three legs at four feet centres, each leg consisting of three pieces of 9″ x 3″ with strapped joints; trestle diagonals were provided in the same way. The transom was 12′ x 10″ x 6″, and the ledger was made up of 9″ x 3″ timber. Owing to the weight of the timber, the total weight of the trestle was approximately 1½ tons.

Four tackles were used; two main tackles slung from the roadway near the abutment were made off to the tops of the outside legs near the transom, two preventer tackles slung from the bridge near the original central pier were made off to the feet of the legs near the ledger. The transom was raised by means of the main tackles; by taking up more rapidly on the longer of the two, the trestle was gradually turned over, and the feet of the trestle were brought into position by means of the preventer tackles, aided by crowbars and levers used under water. When the feet of the trestle were resting approximately in position and the transom was lying against the abutment wall, the preventer tackle was cast off the feet and was lashed to the tops of the legs, and the trestle was then pulled vertical.

Two platoons were employed on this work, which included improving the approaches, making a turning point for armoured cars, and building a small blockhouse, and the bridge was ready for lorry traffic after two days' work, and was opened to armoured cars two days later.

(*g*) *Bridge No.* 2.—This bridge consisted of two 34-feet spans, 20 feet above ground level, with a stone pier in the centre of the gap. The roadbearers in each span were four 16″ x 6″ R.S.J.s

carrying single 3″ decking. One span had not been touched, but in the other the decking had been destroyed, two of the roadbearers had been thrown into the water, and the shore abutment, which was built of laterite blocks in cement, had been attacked and badly damaged. The two roadbearers which had fallen were bent through an angle of about twenty degrees, while the other two were still resting precariously on the damaged abutment.

A derrick was erected through the centre of the roadway, and the two R.S.J.s, which were still in position were lowered on to a ledge in the abutment wall, so as to enable the abutment to be repaired. This was done by digging down to a level seating and building up to the original level with timber cribwork carrying a shore transom of 12′ x 10″ x 6″. The two undamaged roadbearers were placed in position as the outside roadbearers, and the two which had been bent were raised and placed between the two outside ones at about three feet centres.

Owing to the amount of bend in the R.S.J.s, they would not sit upright, and were therefore supported by block and tackle from the derrick which had been used to raise them. Distance pieces having been put in between the ends of the girders, their centres were pulled together by means of block and tackle until the two were practically straight. Three Spanish windlasses of 600-lb. telegraph wire were then twisted up until they took the strain, and the blocks and tackles were cast off. Double decking of 9″ x 3″ timber was added, and the bridge was opened for armoured car traffic 2½ days after work was first started on it.

(*h*) *Bridge No.* 3 (see Photographs 1 and 2).—Consisted of two iron lattice girders over a gap of 100 feet, carrying a metalled roadway, which was supported on built-up iron cross-beams at five-feet intervals. The ironwork of the bridge weighed from 45 to 50 tons, and the road metal approximately the same, the bridge being supported on brick abutments at a height of about 20 feet above ground level. The rebels had attempted to destroy the bridge by attacking one of the abutments with pick and crowbar, and had persisted in their attempt until the end attacked had commenced to settle; probably the first movement of the bridge had caused them to think that their work was accomplished, besides bringing home to the men working underneath the fact that their position would not be exactly enviable when the bridge finally collapsed. When the bridge was examined, it was found that the two bedstones at the damaged abutment—these stones were approximately 6′ x 5′ x 3′, and were bolted to the girders—had been undercut to such an extent that they were resting on a bearing of about 2′ x 9″, consisting of crushed and broken brickwork, and that one girder had sunk about 9″ and the other about 3″. It was decided that the bridge should be left until more suitable appliances in the way of heavier lifting jacks,

bricks, cement, etc., could be obtained, but next morning it was found that the lower girder was still settling, and that it was now 18" below its original level. In addition, news had been received which pointed to the possibility of the road being required for operations, and steps were at once taken to reduce the weight on the seating by removing all the road metal on the bridge. Two six-ton jacks—the only lifting appliances available—were then put in position below the bedstone, and the weight of the girder was taken on them, the broken brickwork being cleared out from behind the jacks once the weight had been taken. The inner half of the abutment was then packed up with timber below the girder, which was slowly raised by means of the two jacks working together, the timber work being built up as the bedstone lifted. When the girder was back at its original level, the jacks were removed and a second closely packed timber pier was built in their place and wedged tightly against the bottom of the bedstone. A similar procedure was then adopted in the case of the other girder, and, after a proportion of the metalling had been replaced, the bridge was opened for traffic.

In order to facilitate the eventual permanent repair of the bridge, and also as a measure of precaution, a timber trestle was erected close to the damaged abutment and wedged tightly against the girders. This trestle was made of very heavy teak logs found on the site, and consisted of two legs, 20' x 18" x 18" immediately under the girders, with a 12" x 12" ledger and transom let into the legs, and with diagonals and struts of about 9" diameter logs. The bridge was opened for traffic after two days' work, and a further two days were spent in building and erecting the teak log trestle.

II. CAMP DEFENCES.

An early type of perimeter was formed of A.T. carts and bamboo, the carts being fastened together and the long bamboo trees with their spiky branches being tied to the carts (see *F.S.R.*, Part II, para. 179). This form of perimeter was often used when on the march, and when carts were not available, the bamboos were anchored down to stout posts driven into the ground.

There was another type of obstacle, originally designed by an infantry officer, which was employed on several occasions in the protection of camps which were more or less permanent. Bamboo tripods about six feet high were erected at intervals of about 20 feet, wire or thin strips of bamboo being used to bind them together, and the feet of the tripods were let into the ground or anchored down. Horizontal bamboos with the thorns left on were then tied to the legs of the tripods, three lines of horizontal bamboo in front and three behind. Pointed stakes were added pointing upwards and outwards, and were made fast to two of the horizontal lines of bamboo.

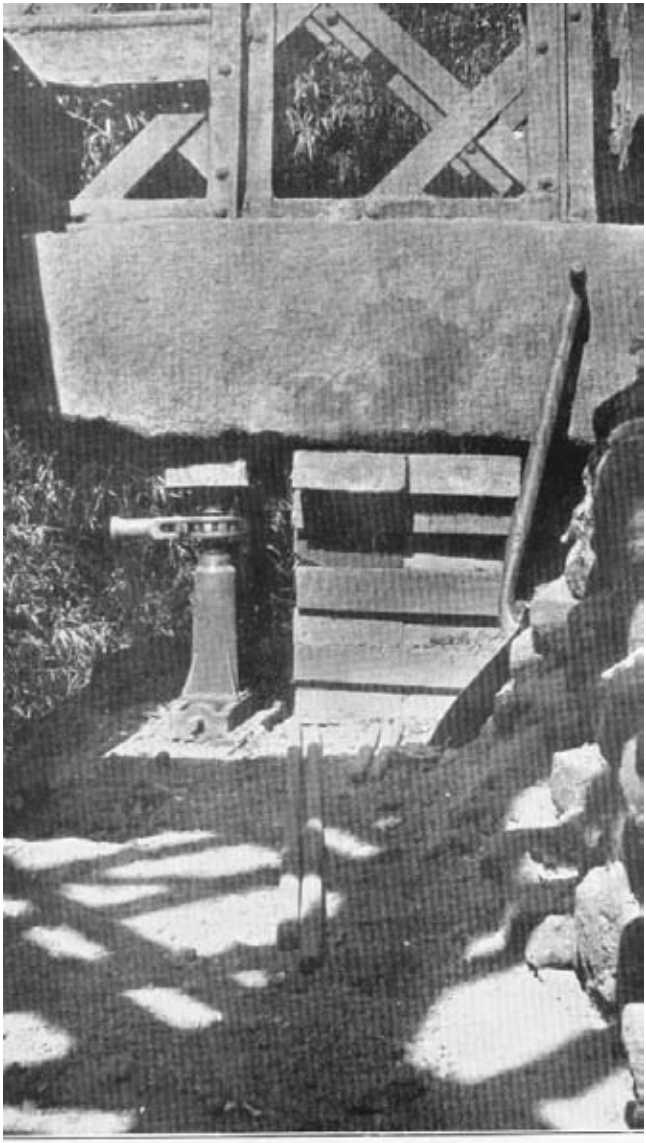
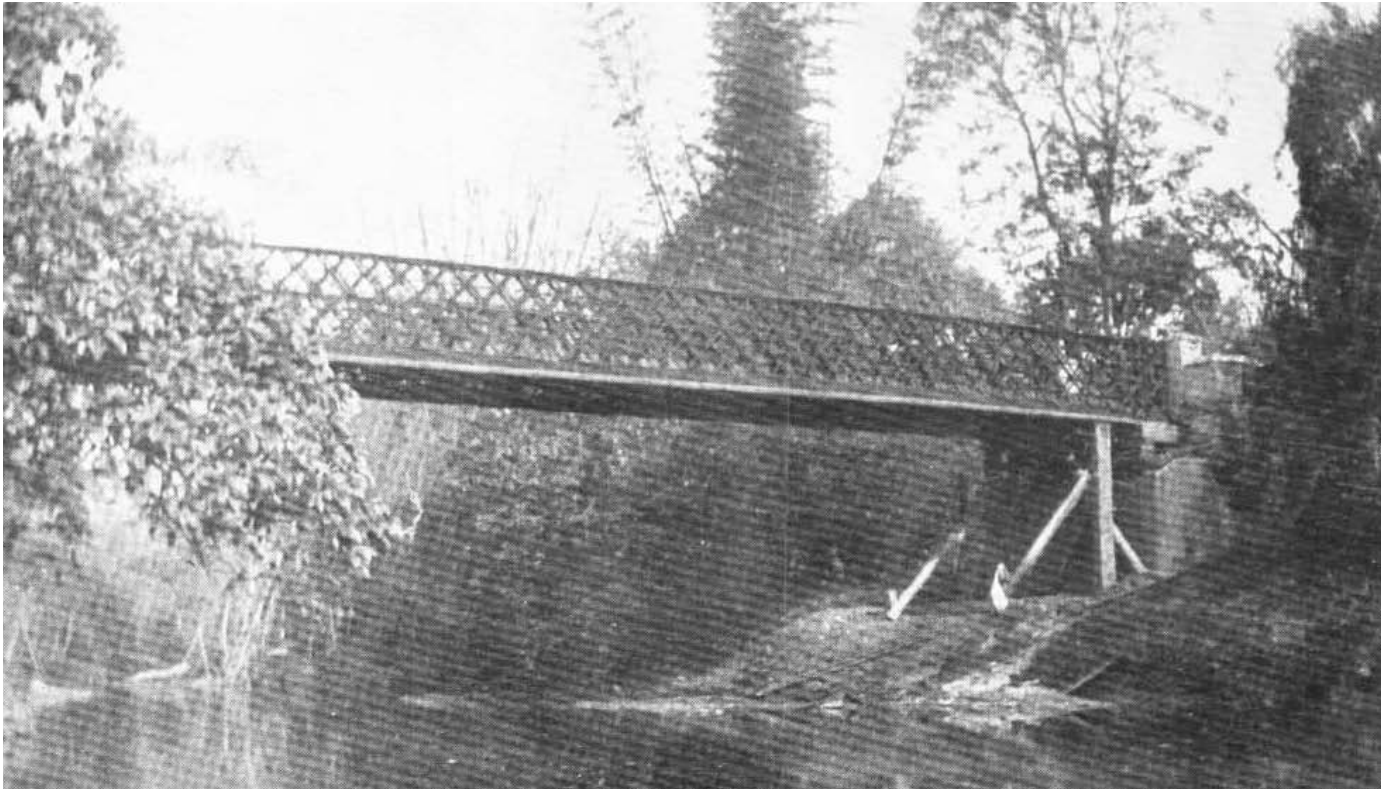


Photo No. 2.—Raising bedstone of Lattice Girder Bridge.

Raising Bedstone of Lattice Girder Bridge.



Repair of Lattice Girder Bridge

Although only possible in a country where bamboo is plentiful, the resulting obstacle is extremely strong; with a little practice it can be erected very rapidly, the only materials required being bamboo and cutting tools, and if necessary the whole work could be carried out by coolie labour.

Owing to the fact that the strength of the garrisons in the more important posts was continually varying, permanent camps were usually constructed with a central keep capable of defence by one platoon, and round this keep ran an outer obstacle, within which there was sufficient room for the largest number of troops who would occupy the camp. This area was then divided into compartments by means of "switch" lines of obstacle, so that any intermediate formation could find accommodation suited to its numbers. The actual siting of the outer obstacle and of the keep depended naturally upon local conditions, but the principle remained the same.

III. Miscellaneous.

Among other tasks which had to be performed was the salvage of two motor lorries from a river into which they had been thrown by the rebels in the early days of the rising. One of the lorries was floated by means of two country boats, after the stones with which the boats were filled when the lorry was made fast had been thrown out. The bottom of the river was filled with boulders, and the lorries had to be floated some distance before a suitable place was found for cutting a ramp to lead them up to the road.

Other jobs varied between helping in the construction of a telephone line between Tirur and Malapuram and forming an escort to a number of Government elephants which had been recaptured from the rebels, and at all times the most urgent cry was for at least some sappers to accompany any column which was ordered out. On one occasion, an N.C.O. and eight men had been left behind in charge of a dump, and the N.C.O. was ordered by the Post Commander to detail a party of Sappers and Miners to accompany a column which was going out next morning. Having been taught to obey orders he did so, but as he had other work in hand he found he could only spare two men. Two sappers accordingly reported to the commander of the column next morning, and as they had been told to bring tools, one of them carried a felling axe and the other a handsaw. The magic of their presence was enough, and they accompanied the column without incident until it had completed its task. If it is true that in war the moral is to the physical as three to one, then the presence of the two sappers may be said to have been trebly justified

THE SHANNON HYDRO-ELECTRIC POWER DEVELOPMENT.

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

Two previous articles on this scheme have already been written and published in the *R.E. Journal*,* but as work is progressing so rapidly no apology is offered for a third.

If any R.E. officer should find himself with time at his disposal in Ireland, he would find a visit, or several visits, to the various sites extremely good value.

The constructional work at present in hand consists primarily of six tasks:—

(1) The excavation and erection of embankments along the Shannon between Banagher and Portumna, embanking and dredging Lough Derg to obtain a storage of 11,500 million cubic feet.

(2) Earthworks between Killaloe and O'Briensbridge and the provision of an adequate means of discharging the tributary rivers and rivulets.

(3) Erection of the weir at Parteen Villa and of the intake building to the head race.

(4) The construction of the head race canal, which is $7\frac{3}{4}$ miles long and has a cross-section of approximately 10,000 sq. feet, with embankments up to 60 ft. high, and the necessary syphons, culverts and road bridges.

(5) Construction of the dam, power-station and two navigation locks at Ardnacrusha.

(6) The excavation for the tail race.

These may be visited on any day of the week, work on them is being done practically continuously during daylight and in certain cases 24-hour shifts are being worked on special jobs. Permits must be obtained from the Resident Engineer, Shannon Power Development, Strand Barracks, Limerick, but there is no difficulty about this, as every endeavour is made to encourage visitors.

I. HEADWORKS.

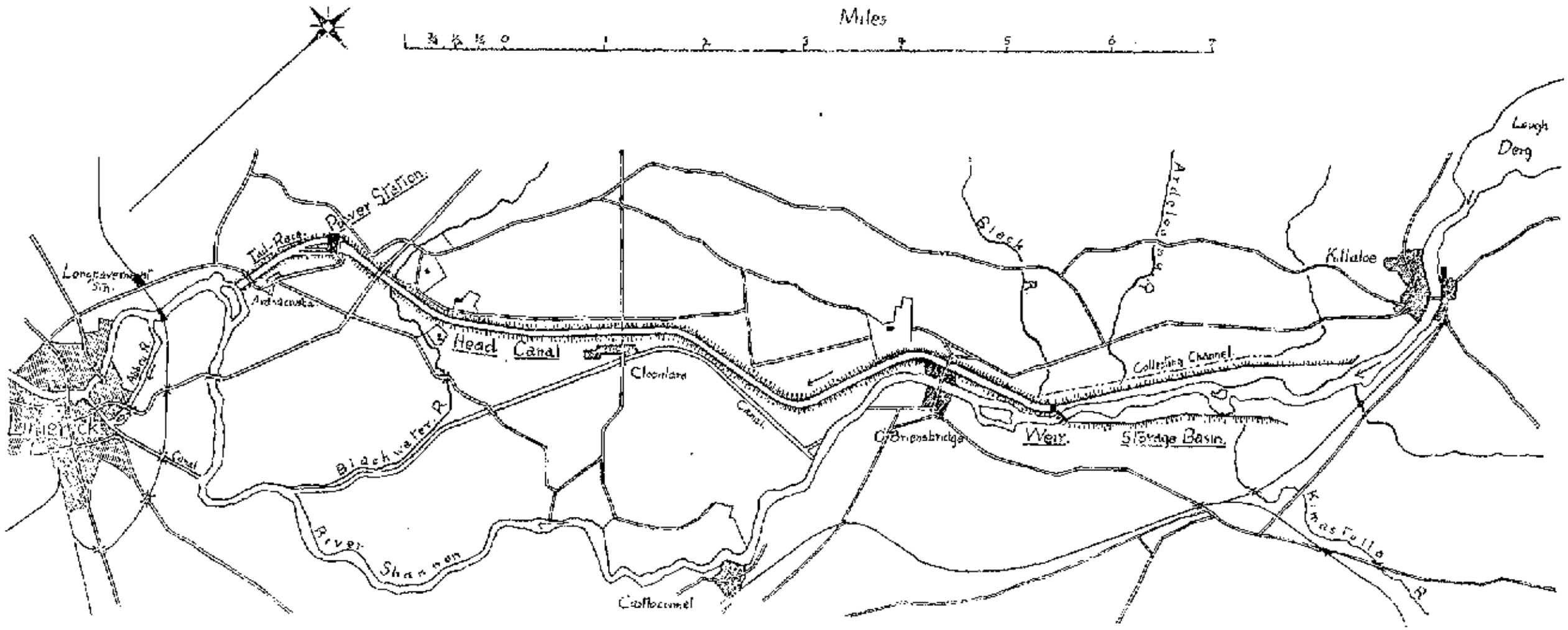
(*a*) *Above the Weir.*

The earthworks above the weir have now reached 75% completion. The embankment on the north side of the river immediately

* *R.E. Journal* for June, 1927, and September, 1928.

SKETCH SHOWING GENERAL PLAN OF SHANNON SCHEME.

Fig. 1.



above the weir is now finished (see sketch showing general plan of Shannon scheme in *R.E. Journal*, June, 1927, reproduced herewith) (Fig. 1). Work is now being done on the embankment on the south side.

The Kimastulla river is being taken through a diversion channel behind this embankment, and its point of discharge will eventually be below the weir.

The Ardeloony river is not interfered with by the works, as its level is such that it can discharge into the storage basin which will be formed between the embankments.

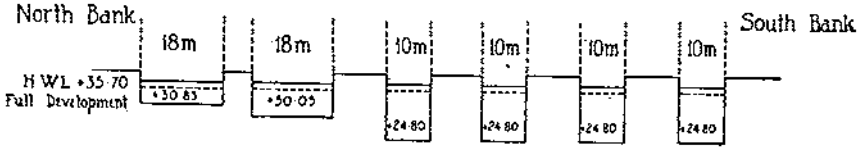
(*b*) *The Weir.*

The original design of the weir was determined by the results of model experiments carried out by the German engineers in Berlin.

The maximum flood to be discharged through the weir is taken as 32,400 cusecs, or 920 cubic metres per second, assuming no discharge through the head race canal. To provide for this, the following weir openings were taken: four openings, each 18·0 metres wide, two with weir crests at level +30·85 and two with crests at +30·05, and two deep sluices each 10 metres wide with crests at +24·80.

The upstream water level is fixed at +35·70 for the final development, and the downstream high-water level is estimated at +28·20. The average level of the river-bed at the weir is +24·50, the upper surface of rock being +22·00.

In order to provide better regulation at low-water level, the original design of the weir has been modified, and it will now consist of two openings, each 18·0 metres wide and four deep openings 10 metres wide, with weir crests at 24·80 thus:—



Final Arrangement of Weir Openings.

FIG. 2.

This design enables the weir with one of its deep sluices closed for repairs to discharge the maximum flood of the Shannon, 920 cubic metres per second, with the head race closed.

The 18-metre sluices will be closed by single steel roller gates 2·7 and 3·5 metres deep respectively, and the deep sluices will have double roller gates divided horizontally and of a total depth of 10·9 metres. The hoisting machinery, which can be worked electrically or by hand, will be housed in a roofed gangway immediately above the gates. As a safety measure and for cutting off the water during

repairs to the sluices, recesses for stop beams are provided in the piers; the steel stop beams being lowered by a crane of special design.

The weir building site has two overhead travelling cable cranes

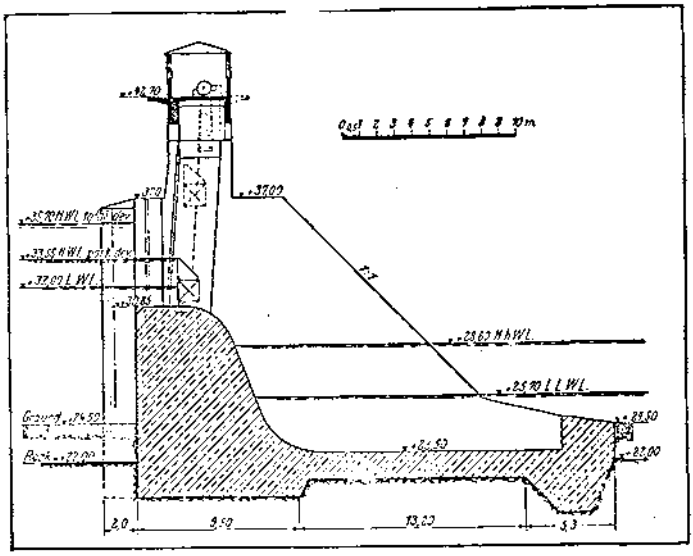


FIG. 3.—Cross Section of Weir.

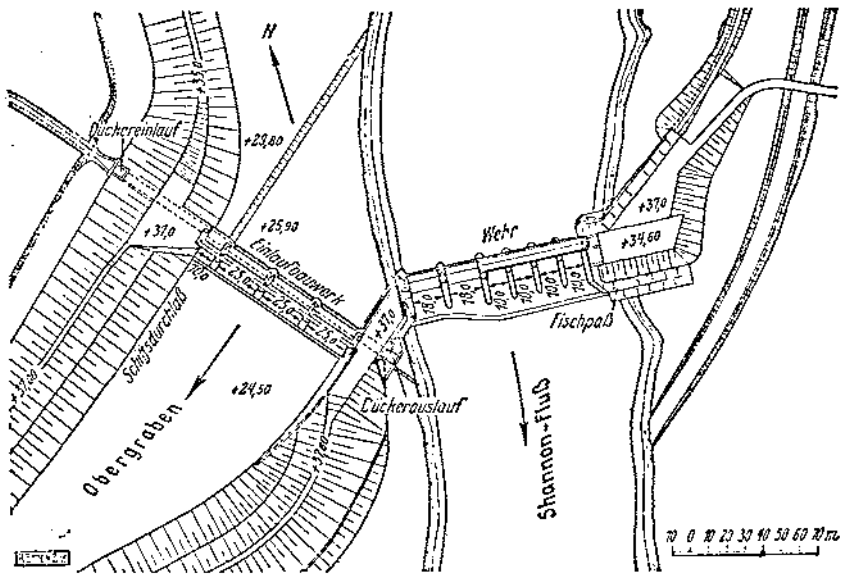
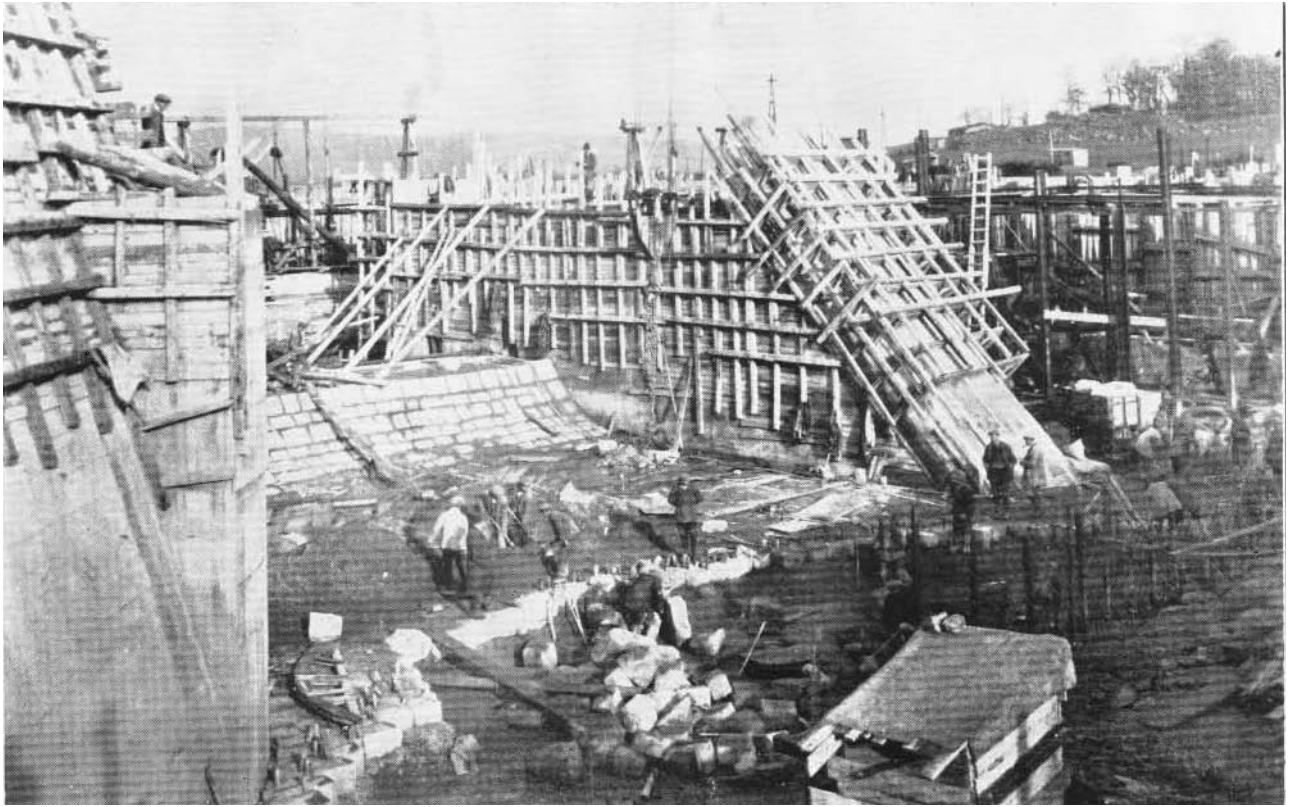


FIG. 4.—General Plan of Weir.

with a radius of about 450 metres, which extend over the Shannon and over the greater part of the intake building site on the right bank. Each carrier is built to lift five tons. On the right bank, the cranes have a common fixed tower, on which the control huts are



SHANNON HYDRO-ELECTRIC POWER DEVELOPMENT

Transport of Concrete

mounted. On the left bank there are two separate towers, both movable, so that the cranes can work over the whole area of the weir building site.

The construction of the second coffer dam was identical with that of the first (already described in previous articles), with the one exception that concrete was substituted throughout for the puddled clay, and so the thickness of the walls was reduced to three feet.

Excavation has to be carried down below the bed of the river to a depth of 3·5 metres, first through a top layer of earth and boulders, then through fissured sandstone rock into sound, hard, red sandstone rock, on which the superstructure is founded. The rock drilling is done with compressed air-drills operated by electrically-driven Flothman compressors. The excavation grows more difficult as the depth increases, owing to percolation through fissures in the rock below the coffer dam. During periods of high-water in the Shannon, this percolation is so great that it requires five pumps having a combined output of 2,000 cubic metres of water per hour, in order to keep the interior of the coffer dam sufficiently dry to allow excavation to proceed. Excavation is carried on continuously day and night, except for a blasting interval every five hours.

The rock is made watertight by cement grouting. Two rows of holes are bored to a depth of five metres below the weir sill, thus cutting well through the fissures in the rock. After the weir sills have been concreted, the bore-holes and consequently the cracks and fissures are filled with cement grout under a pressure of six atmospheres. In this way, a watertight barrier is formed along the upstream side of the weir to a depth of 8·5 metres below the original rock surface. This, it is hoped, will prove sufficient to prevent water percolating under the weir when the water level is raised to full development.

The actual concreting of the weir is done as follows:—The aggregates from the silos, namely, sand, chips, and broken stone, are dropped into tipping wagons in a tunnel under the silos. The wagons are provided with the necessary quantity of cement by means of an automatic weighing machine, and then raised up a ramp to the concrete mixer. The plant for the weir and intake building is in one hut, and consists of two 1,000-litre mixing machines. The finished concrete is first put on a conveyor belt 20 metres long on an arm that can move round a semicircle. By means of this belt, part of the intake building can be concreted directly. For the concreting of the rest of this building and the weir, the belt conveys the concrete to the carriers of the overhead cable crane, which in their turn bring it to the required place (see Fig. 6).

The spillway basins below the weir are faced with granite blocks 40-60 cubic measurement, quarried at Aughhim, Co. Wicklow. As soon as a layer of foundation concrete for the spillway is ready,

the granite blocks are laid by a special gang of masons and jointed with cement mortar. The stones forming the stop wall of the spill basin are anchored to the concrete by means of round steel bars (see Fig. 7).

To avoid upward pressure on the concrete bed of the spill basin due to water percolating through small cracks and fissures, earthenware pipes are laid along the natural rock fissures, cased with lean concrete, and provided here and there with vertical outlet pipes extending through the concrete to the surface of the spill basins.

Note.—Reduced levels and all dimensions for the weir have been given in metric units to conform with the diagrams kindly supplied by the contractors, Messrs. Siemens, Baunion.

Fish Pass.—A most spacious fish pass will be constructed around the eastern extremity of the weir. The silver fish will leap up the 30-ft. rise by twenty steps, each step only 18 inches high, and connected by pools 23 feet long and 13 feet wide; every third pool will be 40 feet long—a rest pool.

II. HEAD CANAL.

Very marked progress has been made in the construction of the head canal. It has now reached 75% completion. And it is anticipated that it will be ready for water provisionally in March, 1929, but this actual date is naturally largely dependent upon weather conditions.

A full description of the plant used for building the banks and a cross-section of the canal have already been published.

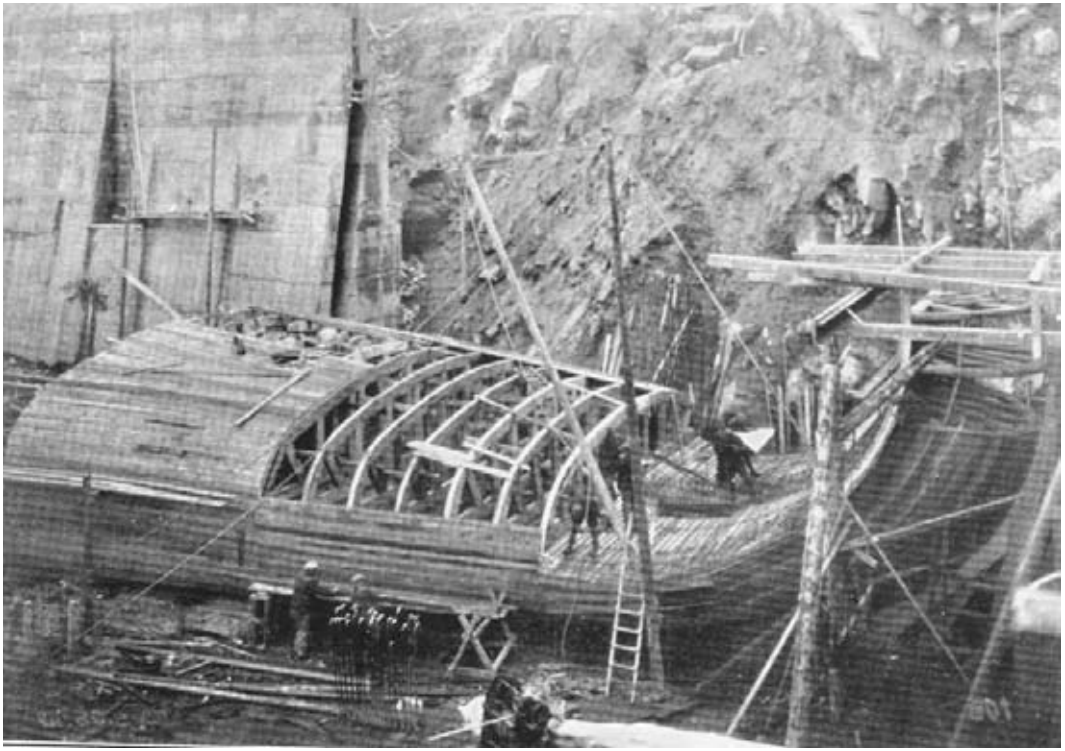
III. POWER-STATION.

The power-station is, perhaps, the most interesting of all the works at the present moment.

(*a*) *Foundations.*—All excavation is now completed. The foundations are built on blue limestone rock, which was found to be homogeneous with the exception of one small part, immediately under the proposed location of the draught tubes of Nos. 1 and 2 turbines, where an earth pocket was discovered. In order to avoid any risk of the concrete cracking, the earth was removed for a further depth of 10 feet and replaced by a reinforced concrete raft some 4,300 sq. ft. in area. The ruling pressure on foundations has been taken as four tons per sq. ft. throughout.

(*b*) *The Dam.*—The concrete work of the dam is practically completed. It has reached the floor level of the sluice-operating gear house. On the head race side of the dam there are six inlets. Only three of these will be used for the partial development, the other

General View of Dam



False work for draught tube

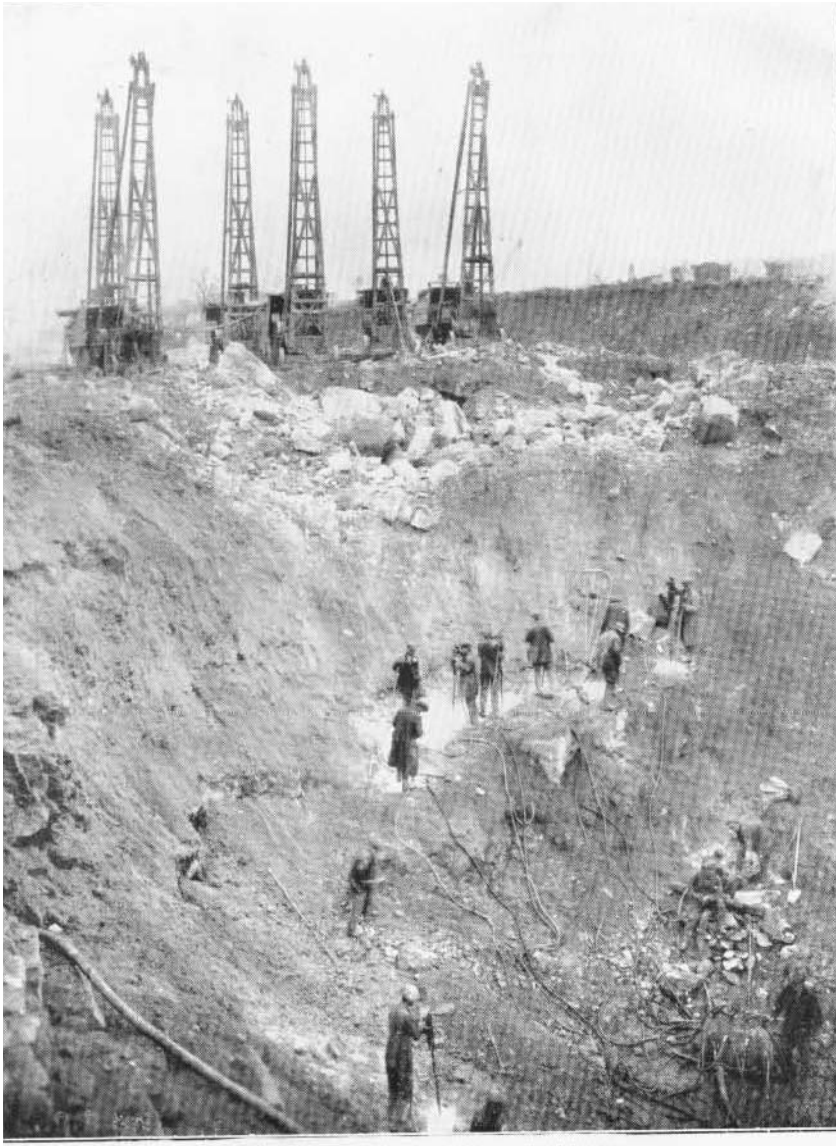


Fig. 13.—Belgian Boring Machines.

BORING MACHINES

three are being closed by temporary walls of reinforced concrete. It will be interesting to see how these will be removed when the time

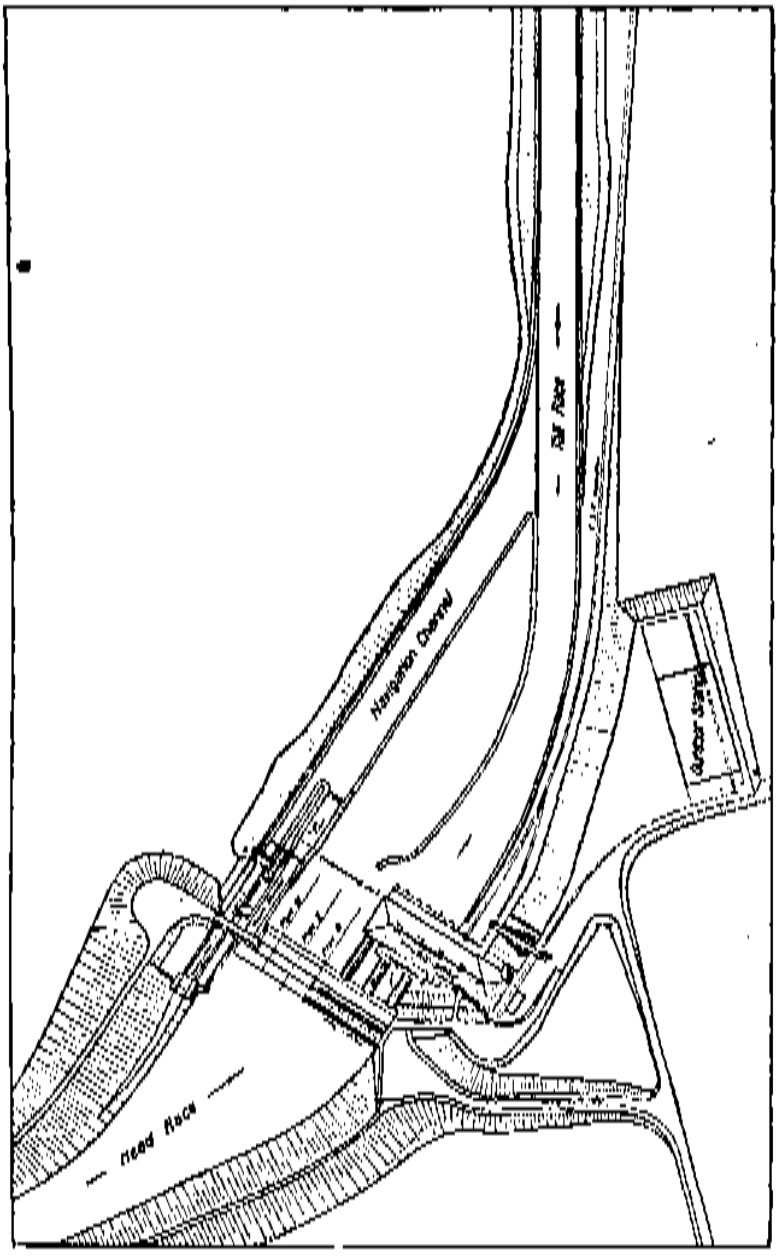


FIG. 3.—General Layout of Power Scheme.

comes for full development. The dam is 123 ft. high, about 300 ft. long, and contains over 2,000,000 cubic ft. of concrete.

Grouting of the rock was carried out here in the same way as at the weir.

(*c*) *Penstocks.*—Separate penstocks are provided for each turbine, they are steel pipes nearly 20 ft. in diameter, with bell-mouthed openings, each closed by means of a roller sluice-gate, and guarded by a trash rack. The gates can be closed, if necessary, in 30 seconds, either from the bridge immediately above them, or from the power-station. An automatic mechanism will be connected to the turbine governor and arranged to close the gate should the speed of the turbine exceed a certain pre-determined maximum. The penstocks

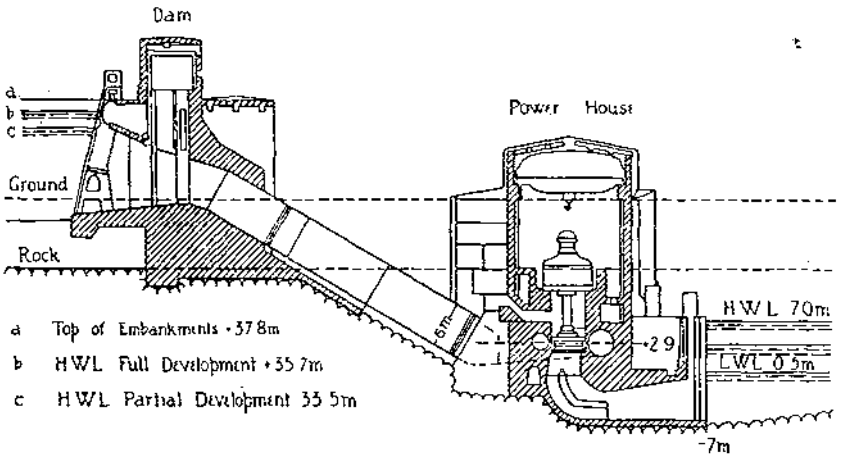


FIG. 10.

terminate in a spiral steel housing embedded in concrete, from which the water is fed direct to the guide vanes of the turbines (see Fig. 7).

(*d*) *Waste-Water Channel.*—Regulation at the power-station end of the head canal is obtained by a special waste-water channel, which has been built at the east end of the dam.

(*e*) *Locks.*—Adjacent to this are the two navigation locks each to lift ships of 150 tons a height of 55 ft. The locks are 18 ft. wide and 1,050 ft. long. The original intention was to instal a ship-lift for the whole drop of 110 ft. Certainly ships would have been lifted more quickly, but the total navigation at the present time is not sufficient to make this an economical proposition.

(*f*) *Turbines.*—Three turbines (two Voigt and one Eiser-Weiss) of 38,600 h.p. each, are being installed for the partial development, and three more of the same size will be added for the full development.

Each turbine is directly coupled by means of a vertical shaft to a

30,000 kw. alternator, generating electrical energy at 10,500 volts.

The thrust bearings of the turbines are designed to take a maximum load, including the water pressure, of 480 tons; these bearings are fixed, one immediately over the turbine, and the other, which is a smaller one, over the alternator. The weight of each runner and shaft together is approximately 42 tons.

(*g*) *Overhead Cranes.*—The heaviest single piece of machinery in the power-station weighs 120 tons. Two 100-ton overhead travelling cranes are being installed in such a way that they can be coupled together for loads greater than their rated capacity.

A permanent broad-gauge railway line will run from the Great Southern Railway at Long Pavement right into the power-station.

(*h*) *Draught Tubes.*—The water is led away from the turbines into the tail race by means of reinforced concrete draught tubes. These tubes have a curved longitudinal axis, and gradually change from a horizontal circular section of 15·8 ft. diameter at the turbines to a vertical rectangular one 4·26 x 16·5 ft. at their outlets, 59 ft. away from the centre line of the turbines. The erection of the shuttering proved to be an interesting problem. It was temporarily supported on heavy timber frames, which were gradually replaced by concrete supports. The problem was further complicated by each draught tube having to be bisected by a steel-edged reinforced concrete vane in the elbowed portion (see Fig. 10), which is necessary to prevent whirlpool action. The placing of the reinforcement of this vane is shown in Fig. 11.

IV. The Tail Race.

(*a*) *General.*—In order to reduce the velocity of the spent water, the first 130 yds. of the tail race is sloped up from − 7 to − 3 metres. The remainder of the bed is practically level to the point where it rejoins the Shannon a mile away. The cross-section of the tail race is designed so as to prevent the current from exceeding 5 ft.-sec. when the tide is normal, so that navigation may not be impeded. In the partial development it is 69 ft. wide. The full development will require a width of 138 ft.

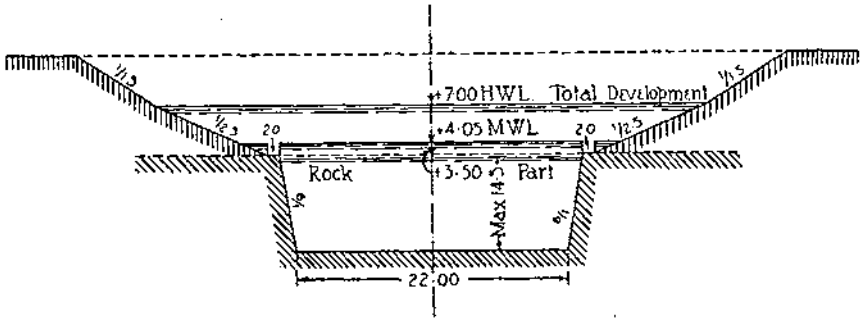
For nearly the whole of its length it runs through rock. This is composed of hard limestone and sandstone, partly interspersed with water-bearing fissures.

(*b*) *Explosives.*—For blasting dry bore-holes ammonal is used, and for those under water ammoniated gelignite. The explosive store is a large isolated and detached hut some distance from the works, and there is also a small detached detonator store. Both these buildings

are underground. They are surrounded by banks of earth and barbed wire, and are under constant military supervision. Both powder and detonator stores are constructed of timber framing with cement walls. The inner timbering is separated from the walls by a 4" layer of air. The floor is constructed on the same principle. The roof is composed of slates lined with ruberoid. The buildings are also well protected against lightning by means of numerous conductors.

Blasting is done in both big and small bore-holes. Compressed air drills are used for the small holes, which are 1½ inches in diameter and of varying lengths, according to the nature of the rock.

(*c*) *Big Bore Blasting.*—Blasting by the big bore-hole method has proved to be very successful. It is found that three bore-holes of 8" diameter at 24-ft. interval are sufficient for the whole width of the tail race (69 ft.). To expedite the work, a second row of three bore-



Cross Section through the Tail Race.

FIG. 12.

holes is sunk at the same time 24 ft. further back from the face of the cliff.

The explosive is lowered into the bore-hole and rammed with a heavy rod. The primer with the detonator is placed on top of the charge. The whole is then tamped with wet clay and fired electrically. Electric firing effects a considerable saving of explosives, as it ensures a simultaneous detonation of all six charges.

Fig. 13 shows the Belgian boring machines at work.

V. ELECTRICAL TRANSMISSION AND DISTRIBUTION.

Electrical energy will be generated at 10,500 volts in the power-station at Ardnacrusha.

Immediately outside the power-station it will be stepped up in an outdoor transformer-station and fed into overhead high-tension transmission lines.

The 110 kilo-volt lines form the primary transmission system; a three-phase line of six conductors will run from Ardnacrusha to Dublin, distance of 116 miles, and a single three-phase line from Ardnacrusha to Cork, about 59 miles.

The 38 kilo-volt lines form the secondary system, which is fed by three 110/38 kilo-volt transformer sub-stations at Ardnacrusha,

FIG. 14.—Map of Distribution System.

Dublin and Cork. The secondary system has been planned to provide loop distribution as shown in Fig. 14.

The tertiary system will consist of 10 kilo-volt lines, which will be supplied by transformer-stations at each of the places marked on the map (Fig. 14). The 10 kilo-volt lines are not shown, as their exact location has not been definitely settled.

Final distribution will be from 10,000/380/220-volt transformer-

stations situated in every town and village, by means of three-phase supply at 380 volts for power and 220 volts for lighting.

Construction.

(*a*) *Supports.*—A maximum span of 820 ft. has been selected as the most economical for the 110 kilo-volt transmission lines, and 650

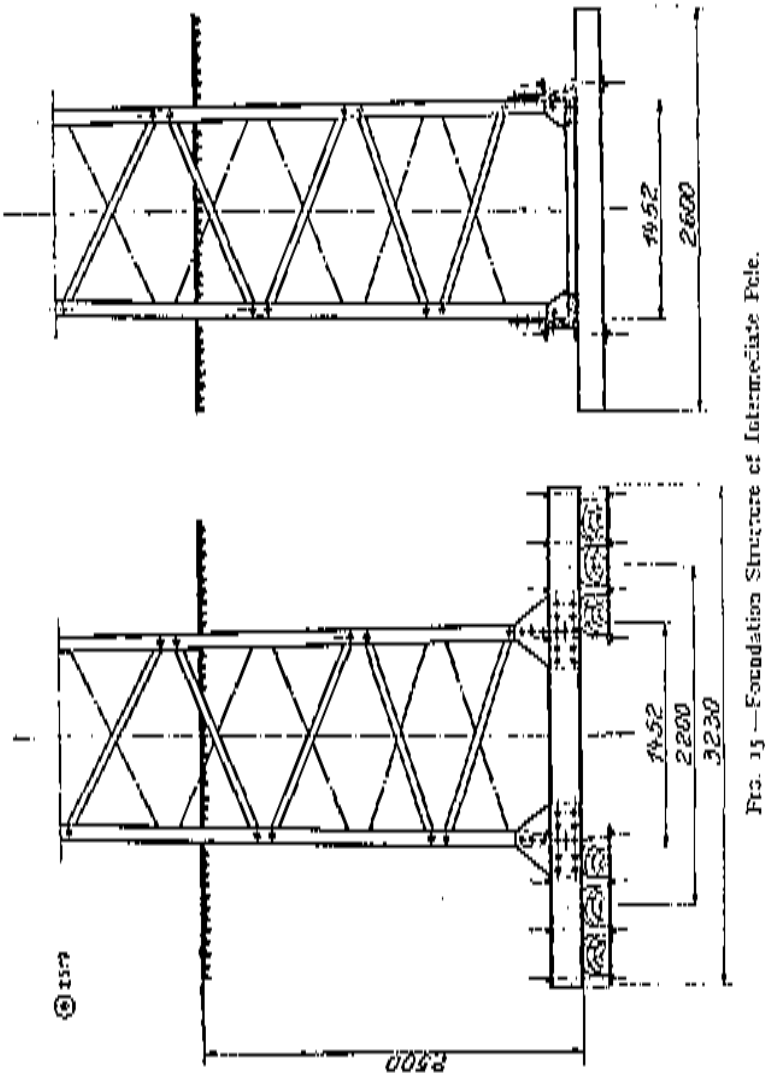


FIG. 15.—Foundation Structure of Intermediate Pole.

ft. for the 38 kilo-volt lines. The minimum clearance of the lowest point in the span of the conductors above ground level has been taken as 24 ft. for the 110 kilo-volt lines, and 22 ft. for the 38 kilo-volt lines. Road and railway crossings 24 ft. on all lines, and crossings over telephone wires at least 6 ft. clear.

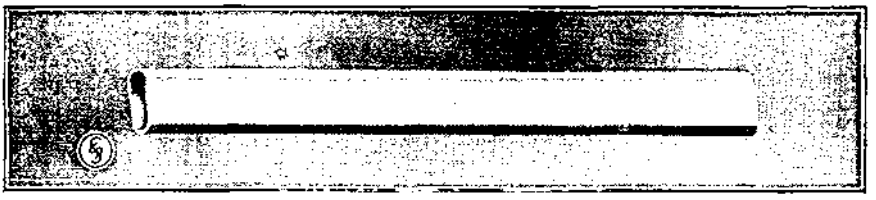


Fig. 17. -Jointing of Conductors.

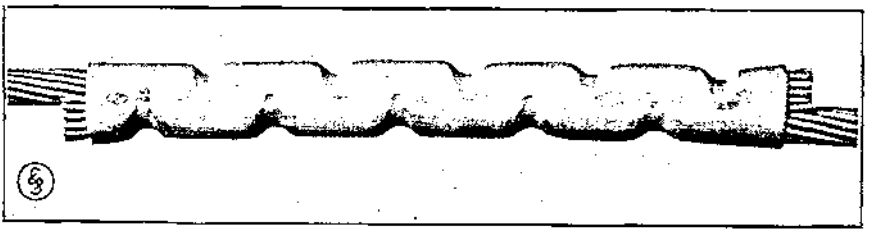
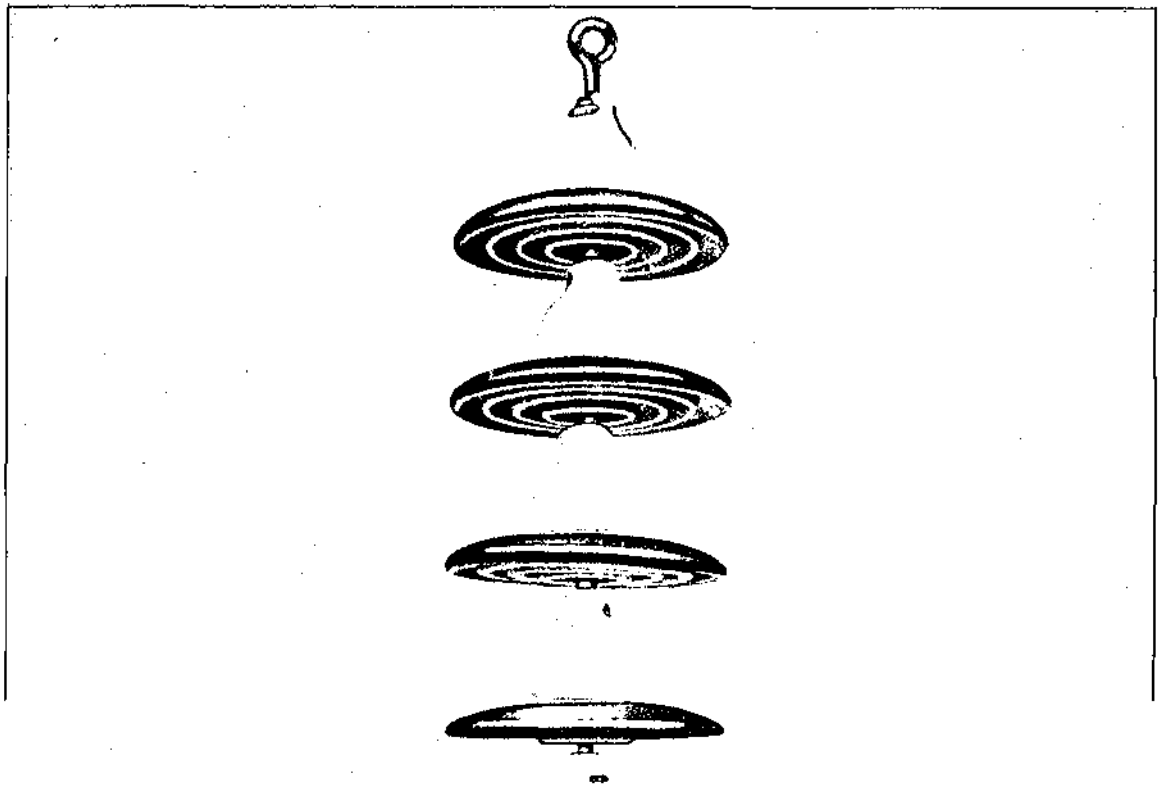


Fig. 18.—Connector in position.



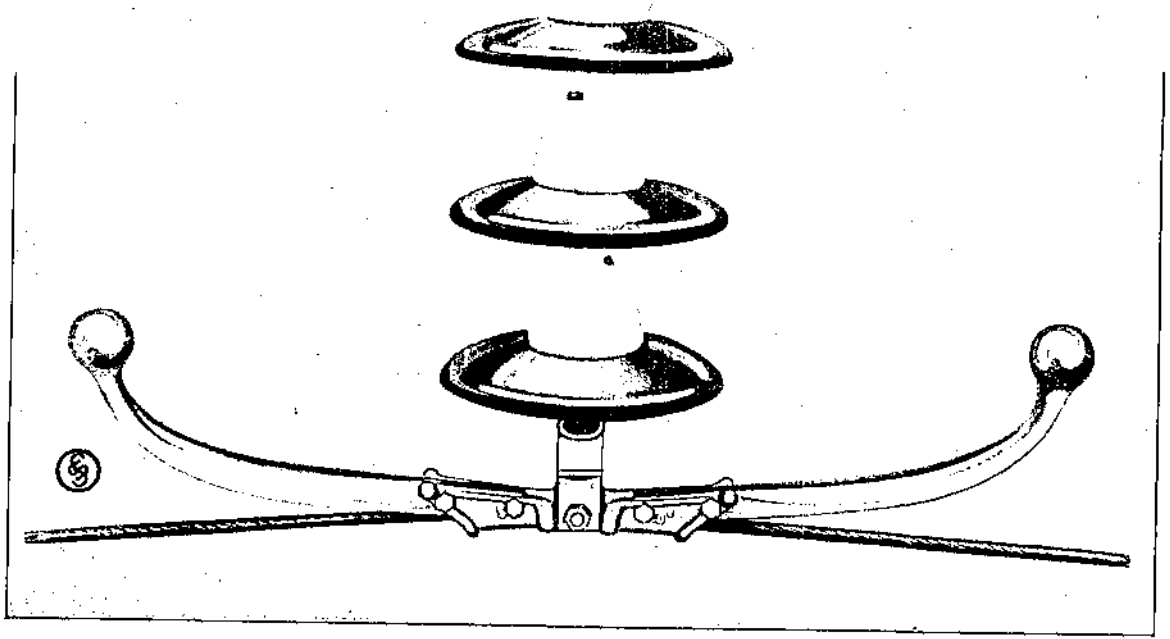


Fig. 19.—Normal Insulator Chain and Suspension Clamp.

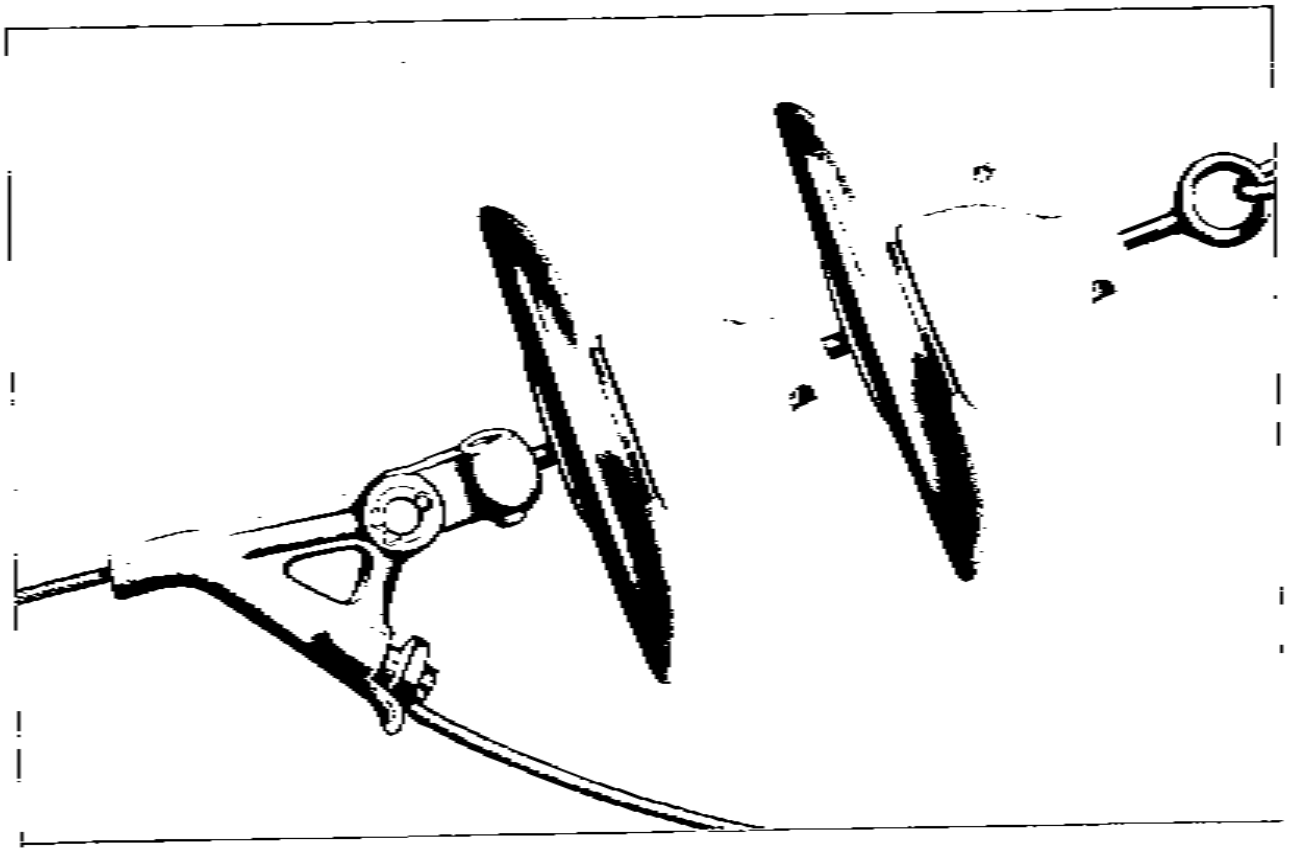


Fig. 20.—Terminal Insulator Chain.

The normal pole sizes are as follows :—

	Height above ground.	*Depth below ground.*	
	Feet.	Feet.	Inches.
110 kilo-volt 6 conductor lines	70	8	6
110 kilo-volt 3 conductor lines	61	8	6
38 kilo-volt lines	49	6	9

The 110 kilo-volt lines are built entirely on lattice steel masts, while the 38 kilo-volt lines are built on lattice steel masts in the southern area and on wooden poles in the northern. For the 10 kilo-volt lines wooden poles are used throughout.

The lattice poles are set on wooden sleepers, fixed to channel irons on the pole base. The sleepers are impregnated with tar-oil and the ironwork underground is treated with hot asphalt tar.

The normal cross-section of the lattice poles is square (Fig. 15). No stays or struts are used. But angle poles are about twice the size of ordinary poles. They are sunk to a depth of 10′ 6″ below ground level, and double-braced to an extra heavy foundation.

(*b*) *Conductors.*—A very ingenious type of suspension clamp is used for fixing the conductors, it is made of gunmetal and fitted with a copper inset thimble which protects the conductor as shown in Fig. 16.

The conductors themselves are hard drawn copper cables with an ultimate breaking strength of 25 tons per sq. inch. The 110 kilo-volt line is wired with 0·147 sq. inch stranded cable, and the 38 kilo-volt line with 0·0775.

For exceptionally long spans on the 38 kilo-volt lines, 37-strand bronze conductors 0·147 sq. inch are used. These have an ultimate tensile strength of 6½ tons.

The jointing of conductors is done by means of groove connectors (see Fig. 17). These connectors give great mechanical strength combined with low electrical resistance. The breaking strength for the 0·147 sq. inch connector is approximately 3·7 tons, and of the 0·0775 connector nearly two tons, which is practically equal to the breaking strength of the conductors themselves. Fig. 18 illustrates one of these connectors in position.

(*c*) *Insulators.*—The conductors are supported by chains of seven and two suspension insulators for the 110 kilo-volt and the 38 kilo-volt lines respectively. The insulators employed are identical. They are designed for a dry flash-over at 450 kilo-volt per seven insulators, or 150 kilo-volt per two insulators, and for a wet flash-over (rain three mm./mins. at an angle of 45°) at 338 kilo-volt per seven insulators or 123 kilo-volt per two insulators. Fig. 19 illustrates the normal insulator chain and suspension clamp for 110 kilo-

volt line and Fig. 20 the terminal insulator chain for 38 kilo-volt line.

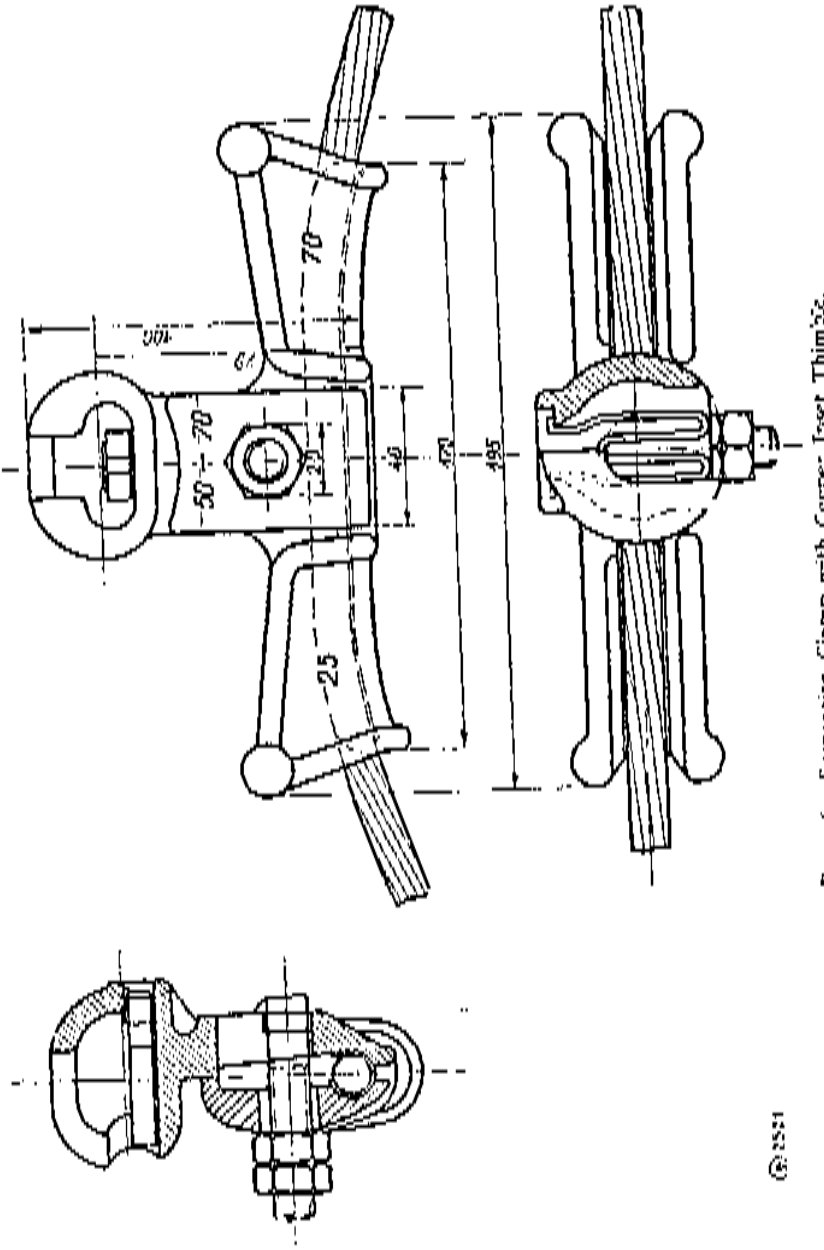
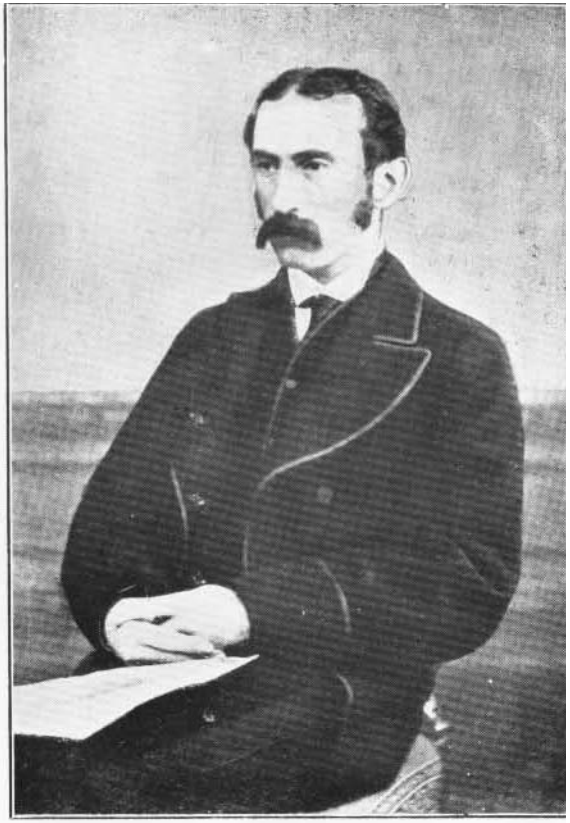


FIG. 16.—Suspension Clamp with Copper Inset Thimble.

The author thanks the contractors, Messrs. Siemens-Schuckert-werke, for their permission to reproduce the photographs and diagrams.

Lieut. R. H. Williams, R.E.,



Lieut. R. H. Williams, B Troop, R.E.,

LIEUT R H WILLIAMS RE

MEMOIR.

MAJOR RICHARD HARRY WILLIAMS.

Foreword.

PERHAPS some apology may seem needed for adding to the Records of the Royal Engineers a Memoir of one who never rose above the rank of Major, and who retired over 40 years ago, with no record of war service to his credit, or of deeds that catch the eye.

I plead, however, in defence, that Richard Harry Williams, a shining example of the Christian soldier and gentleman, was enabled through force of circumstances to exercise by example and precept a wide and abiding influence on many men, some of whom were destined to rise to high positions in the national service, and that, in this way, his life work exceeded in essential value that of many with much more brilliant professional records.

An officer of another branch of the Army, in talking of the late Sir Ronald Maxwell as a "white man and a sahib," said to me that the production of such men was by no means unusual in the Corps of Royal Engineers. This was a very high compliment, which we must do our best to deserve: however that may be, among our white men and sahibs the subject of this Memoir deserves a very forward place.

H. M. LAWSON.

RICHARD HARRY WILLIAMS, born at Chatham on May 20th, 1841, was a son of the Corps: his father, Montgomery Williams, joined the Royal Engineers a few months before Waterloo, and served in it in many capacities: he became a Major-General in 1860, a Colonel Commandant in 1867, and a full General in 1872, in which year he died, on the 18th June. He was buried in the churchyard at Findon, in Sussex, where some years previously he had settled down in a cottage, which later on was to be his son's home on retirement.

Harry Williams was the youngest of four children; the eldest, Caroline Amelia, married Major-General Lewis Frederick Hall, R.A., himself the son of a General, R.E.; the second, Rose Alexandrina, died unmarried in 1911: the third child, Sydney, served in the Royal Marine Artillery, and died in 1881.

Williams and his sister's children were mutually devoted, and to one of them the writer is indebted for material and information, without which this Memoir could not have been written. Williams

got his first commission in October, 1858, too late for the Crimea and Indian Mutiny, but as a Cadet he marched past Queen Victoria, when she visited Woolwich on March 13th, 1856, to welcome her soldiers returning from the Crimea.

After completing his courses at Chatham, Williams served in Ireland for 2½ years, and then joined the 22nd Company, R.E., which, under the command of Major Edwards, embarked at Portsmouth on August 1st, 1863, for Hong Kong.

After the lapse of years, it is difficult to get testimony as to the Williams of his boyhood and younger manhood, but it is possible to glean something.

He was artistic from the first, a beautiful draftsman, illuminator, and water-colour artist; he had a wonderful ear for music, which enabled him, without any instructed knowledge, to pick out tunes on the piano and organ, and made it possible for him, on many occasions, and for extended periods, to perform the duties of organist in church. The religious instinct and belief, which was the guiding and predominating feature in his life, must have been of early growth, and, from the first, seems to have developed on definitely High Church lines. There is in existence a most beautifully illuminated book of the Holy Eucharist, done by him, and given to his sister, in the year 1860, on which is stamped his school of thought, and whose workmanship is a crowning proof of Williams' talents as an artist and illuminator. His love of architecture evidently developed at the same early period, and there can have been few men of his time better versed in the art, more especially in regard to Church architecture; we shall find later that, on more than one occasion, he took a very real and successful hand in Church restoration and decoration.

He was of about medium height, of rather poor physique, and as someone writing of his early days describes him, "rather pale and delicate looking, so kind and courteous." He doubtless had, what we who knew him in later years always recognized, something magnetic about him in his sympathy for others, and his power in getting on terms with them; he had also the quality, given to some, of raising those in their company, at any rate for a time, to their own moral and spiritual level. He was a very good conversationalist, full of humour and cultivated to a degree: his own modesty and, in later years, his feeling of growing deafness, made him retiring, but those who knew him best realized how calculated he was to shine in any company. He was generally very well read, and, lastly, he wrote in a beautiful hand a surprisingly good letter, so descriptive, so conversational, so lighthearted, and yet so interesting.

He maintained this latter quality to the end, and my wife, who never knew R.H.W. except through his letters to me, would never miss them when they came; in them there was the same attraction which we, who knew him personally, found in his company.

To return to our narrative, the hired transport, *Louisa*, a sailing vessel of 902 tons, conveyed the 22nd Company, R.E., to Hong Kong: it took two and a half months to reach the Cape, and the same time to get from the Cape to Hong Kong. It must have been very rough travelling in those days, judged by modern ideas, and the mortality of women and children recorded in Williams' journal sounds deplorable. Williams took a hand in the Sunday services, organized the choir, and gave lessons in geography to those who wished it.

Arrived at Hong Kong, he seems early to have found favour with the Governor, Sir Hercules Robinson, for when the latter was transferred to Ceylon a few months later, he was very anxious to have Williams on his staff: things went so far that Williams followed Sir Hercules to Ceylon, in the hope of being allowed to take up the duty, but the War Office was obdurate, and Williams had to return to Hong Kong.

His journal shows how much Williams enjoyed life in Hong Kong (January, 1864, to July, 1866), and he made great friends there with Duncan Davidson, about two years his junior, who was employed for some years in one of the business firms at Hong Kong. Davidson was a wonderful athlete, and excelled at every description of sport and game, and he combined this with deep religious views; he and Williams attended many a church service together, and great was the grief to both, when, in April, 1866, illness caused Williams to be invalided home. This early friendship illustrates the attraction which those who were proficient at games and sport exercised on Williams, and one finds the same trait in later years, at Sandhurst, when so many of his "war pups," as he called them, were the recognized leaders of the cadets in athletics.

When Williams got home, he found his father, mother, and sister living in the cottage at Findon that some of us got to know so well in later years, and we find him taking up at once, with great vigour, the restoration of the parish church; later on, he paid a much appreciated visit to his friend Duncan's family at Inchmarlo, Aberdeenshire, where he enjoyed the friendly welcome, the lovely scenery of the Dee, and the interesting glimpse of Queen Victoria and her family, when presented to them at Aboyne.

A photograph of himself which Williams sent to his friends at Inchmarlo two months after his visit there, is reproduced, thanks to the kindness of Duncan Davidson's sister, Miss Davidson, of Inchmarlo Cottage, to whom the writer is also indebted for most helpful information.

At the conclusion of his sick leave, Williams joined for duty at Dover in December, 1866, when he found himself under the command of Sir Frederick Chapman, and where he did regimental duty until moved to Canterbury in January, 1868.

At Canterbury, Williams came in touch with a valued friend, Lieut.

Blood (now General Sir Bindon Blood, G.C.B.), about two years his junior in the Corps, and it is characteristic that Williams' parting present to Sir Bindon, when the latter sailed for India in the early 'seventies, should have been a copy of *The Imitation of Christ*, by Thomas à Kempis.

In this period, Williams seems to have been very much in touch with some of the leading High Churchmen in the country, including Doctor Pusey, whilst he also lent an effective hand to the decoration and restoration of several churches.

When the work at Findon was finished, he took a prominent part in the restoration of St. Nicholas' Church, Sturry, near Canterbury, where much of the mural decoration was done with his own hands. His journal records many visits to Sturry, and the work appears to have been finally completed when he went to Sturry in January, 1874, to hang the chancel gates, and subsequently to meet his old friend, Duncan Davidson, who was home from abroad, and on his honeymoon.

Bowers Church was another one which he helped to restore, and we read that on September 14th, 1868, he commenced painting the roof of the chancel.

A change in his life came in the early summer of 1870, when he joined the 31st Company, R.E., at Shorncliffe, and went with it to Chatham in the August of that year. Here we find mention of another great friend, G. W. Tisdall, then in C Troop, and of whom Sir Bindon Blood speaks as the greatest friend he ever had. The friendship between Williams and Tisdall was obviously very close, too, and Williams saw his friend off, in November, 1871, to India, where Tisdall died in the following summer.

Early in January, 1871, Williams embarked with the 31st Company for the Curragh, but on the 19th of the same month he joined B Troop at Aldershot, where he was destined to stay, with some intervals at Chatham, until September, 1872.

ALDERSHOT IN THE EARLY 'SEVENTIES.

The Aldershot to which Williams went in 1870 was so unlike that of to-day, that it seems worth while to try and indicate the difference, and to record, however imperfectly, what the old hutted camp of the 'seventies was like.

In thinking of the Aldershot of those days, it is well to realize, to begin with, that, unlike the present camp, it could be, and under certain conditions was, a very dusty place. It bore a reputation in this respect which was thoroughly well deserved. Everyone used to talk of Aldershot being dusty, and with reason. The copses which now protect the camp on the west from wind and dust, were only then being planted, and where are now the grassy recreation grounds

along the Farnborough Road, were then tracts of sand and heather : the broad grass strip which now divides Gibraltar and Buller Barracks from those to the south, and which adds so much to the attractiveness and spaciousness of the present camp, was then a mass of huts. In fact, all the ground from the Canal, between the Farnborough Road and the central power-station, to the high ground overlooking the permanent barracks, was covered with huts, with the exception of a small recreation ground, north of the Officers' Mess, Barossa Barracks, and of an infantry brigade parade ground lying south of a line from the site of the present Central Gymnasium, to the top of Gun Hill Road.

The picturing of the camp in more detail is facilitated by realizing that the roads which served it still remain, widened and modernized, but then without their present names. Thus, the great central artery of the Camp, the present Queen's Avenue, was in those days called Middle Road, but it bore little resemblance to the spacious thoroughfare of to-day. The then roads were narrow, highly cambered, and flanked by deep gutters, whilst at road junctions white posts served to show the way at night, and to keep vehicles out of the ditch.

The huts themselves ran in rows parallel to the Farnborough Road, the most westerly row about 130 yards from that road. They were divided into 24 sections called " Lines," lettered from A to Z, omitting J and U. Each Line covered a space of about 170 square yards, and was placed on either side of a north and south road, on the west side of which were two rows of men's huts, 24 in number, and on the east side were the Officers' Mess and quarters, with various accessories. West of the soldiers' huts in each Line was a gravelled space about 70 yards wide, separating the Line from its neighbour to the west and serving as a company and battalion parade ground.

The present east and west roads divided the Lines from one another longitudinally, whilst the north and south roads, which ran down the centres of the Lines, still exist in Mandora Road, Fire Station Road, Maida Road, Queen's Avenue, Barossa Road and Albuera Road ; the only one of these which is not complete to-day is the most westerly one, which does not cross the Green Parade Ground, but is taken up at its northern end by the road that runs north between the R.E. Mess and Burgoyne House.

The huts, some red, some black in colour, and with tarred felt roofs, were placed somewhat close together as judged by modern standards, whilst the diminutive spaces between them were encumbered by iron folding screens on travelling carriages, to be used for isolating burning huts in case of fire, as well as by frequent clothes lines, on which garments as well as pipeclayed belts and gloves hung out to dry ; all this, helped by the narrowness of the roads, served to give a general impression of congestion.

As regards the location of the various Lines, the present Green

Parade Ground accommodated six of them, viz., B, F, L, P, T and Z; Albuera, Barossa and Corunna Barracks are on the site of 5 Lines, viz., C, D, G, H and M; Maida Barracks and the adjoining Married Quarters stand on the ground once occupied by M, Q and V Lines, whilst Gibraltar Barracks are where A, E and K Lines used to be; the site of the remaining Lines, which stretched as far north as Transport Road, is to-day covered by married quarters, C and D squares, Buller Barracks, and part of Mandora Barracks.

The Command Headquarters were at the south end of the camp, in the present needlework hut, and looked out on to the infantry parade ground, whilst south of the Prince Consort's Library, in rather attractive wooded, undulating grounds was what had once been the hut residence of the Commander-in-Chief, but which was later the abode of one of the Infantry Brigade Commanders.

Taking in more detail the Royal Engineers, who were located in K, I and N Lines, let us start a few yards west of the present Command Headquarters, where the Queen's Avenue crosses Steele's Road. This point marked the southern end of K Lines, which ran down on either side of Middle Road (now Queen's Avenue), as far as Alison Road, beyond which I Lines began and continued down to the R.E. Yard and Transport Road. The Third R.E. Lines, N Lines, was the next Line to the east of I Lines, and extended on either side of the present Maida Road, from Alison Road to Transport Road.

Commencing again from the starting point, and looking towards the Canal, the men's huts in double row extended down the left side of Middle Road, the western flank of the K Lines huts being now marked by the eastern ends of the Gibraltar Barracks Blocks, whilst those in I Lines occupied part of the present R.E. Parade Ground.

On the right side of Middle Road, again looking towards the Canal, there were in K Lines, besides some miscellaneous huts, three Officers' Married Quarters, the most northerly one being the C.O.'s hut, with its entrance on Alison Road.

Opposite to the C.O.'s hut, on the other side of Alison Road, was the southern end of the R.E. Mess Compound, with a front on that road of about 30 yards.

The western side of the compound ran along Middle Road, but standing a little back from it, with some servants' huts in between, and its northern end was just north of the west front of St. George's Church. Beyond the compound again were some miscellaneous huts, ending with the school facing Transport Road, and looking across to the iron church a few yards nearer the Canal.

The R.E. Yard was then where it is now, and in lay-out was very much the same as at present, save that the stables and offices were in wood, and not in permanent material.

The Parade Ground, smaller than at present by the space occupied by two rows of huts, served for foot drills, and for occasional demons-

trations of the complicated wagon drill of the day. There was a flavour of unconscious humour about the old order, "The Line will *Retire*," when its first consequence was the command "Right Half Sections will *Advance*."

The formation of N Lines was the same as I Lines, and, like I Lines, provided three Married Officers' Quarters for the Royal Engineers.

There is a particular interest attached to No. 3 Hut, N Lines, which stood close to where is now the Serjeants' Mess Enclosure, of D Square Married Quarters.

It was the usual residence of the Commander of the Pontoon Troop until its last days, when it became the home of the Adjutant.

The hut is chiefly famous, however, because for a period it was occupied by Major and Mrs. Ewing, of whom more is written later in the Memoir.

The R.E. Mess and its surroundings now demands attention.

The Compound was surrounded by a substantial holly hedge, six to eight feet high, with red may trees at intervals, a barrier to dust and dirt from the outer world.

It contained within it, at its southern end, the Mess, with its back to Middle Road, whilst north of the Mess were three officers' huts, each with four quarters so tiny that the occupant could close the door, open the window, and poke the fire without getting out of bed.

Inside the holly hedge in front of the Mess, round the officers' huts and to the north of them, was the much prized and cared-for garden, with its flower beds of true Victorian type, gay with colour in the summertime, and its well-kept paths and carefully mown grass borders.

The main approach to the Compound was from the East, and opposite to the Mess. A visitor passed through the hedge by a wicket gate, and a few yards along a rustic passage brought him to an entrance door and hall. To the left of the Hall was the low but spacious ante-room, with an attractive bow window: beyond the ante-room was the billiard-room, alongside of which lay the Mess Room, where at an inspection dinner as many as forty have been known to sit down.

Another entrance to the Mess led from the garden through the conservatory, an important factor for the garden, and under charge of the officer on whom the care of the garden devolved.*

The married officers' quarters, gay with creepers and tiny gardens, were small when judged by modern standards, but they managed somehow to accommodate considerable families, and to give scope for much modest entertaining, and a pleasant social life.

* *Note.*—The standard of comfort in the Infantry Officers' Messes fell considerably short of the above. The accommodation consisted of two ordinary huts, one for a Mess Room, and one for an Ante-Room; a road separated the two huts and, without any covered passage, the crossing to and fro on a wet or stormy night presented obvious difficulties.

They seem to have made comfortable homes, even though their walls did let in the frost in winter and the heat in summer; happy lives were undoubtedly lived in them, and some officers passed most of their service in these unsubstantial structures.

Aldershot had an attraction then for the R.E. which it does not now possess; at any rate, not to the same extent. It was the home of the Train, containing the only mounted units which the Corps possessed; it drew to it the type of officer who loved soldiering, was fond of horses, liked to wear a scarlet stable jacket, or was attracted by the glitter that undoubtedly appertained to the Train. Officers used to go on there from billet to billet, or return thither after short intervals. In this way there was a continuity established, and a similarity of outlook, which brought about a camaraderie among officers of the Train. It made Aldershot, so far as the R.E. were concerned, a very pleasant home.

Whilst Williams served at Aldershot, that fine old Scotch soldier, Sir Hope Grant, commanded the division, and among his staff were Sir Archibald Alison and Colonel Evelyn Wood. The C.R.E. was Colonel R. M. Laffan, later on Sir Robert Laffan, Governor of Bermuda, whilst another Corps celebrity, Colonel FitzRoy Somerset, commanded the R.E. Train, with Sir Arthur Mackworth as his Adjutant. The A Troop was commanded by Captain Micklem, B Troop by Captain Durnford, and the newly-raised C, or Telegraph Troop, by Captain Lambert, with R. M. Jelf as one of his subalterns.

To Laffan the thanks of successive generations are due for the way in which the Government land was laid out, and planted with its various woods and copses. Many years later, Sir Evelyn Wood, when in command at Aldershot, perpetuated the memory of the C.R.E. of those days by giving to the principal review ground the name of Laffan's Plain.

Williams got to know Evelyn Wood very well, and they became fast friends. Although differing in some respects, they had the same fundamentally deep feeling for religion, and the same healthy, high-minded and progressive outlook on life. Wood was just the man to appreciate Williams' character and to realize what an asset such men were to the Army.

In later years they used to correspond, and, when Williams was an Instructor at the R.M.C., Wood used always to invoke his aid towards getting cadets of promise for his regiment.

This was a period of renewed activity in the Army, the short-service system had just been introduced, and the Franco-German War had led to the first army manœuvres of 1871 and 1872, the former in the vicinity of Aldershot, and the latter round Salisbury Plain. Williams' journal tells us of the part which he and "B" Troop played in those mimic campaigns, and reflects the professional zeal just then awakened in officers of the Army.

The only church in the South Camp at this period was the iron church, or " Tin Tabernacle," as it was sometimes called. The iron church, which was always what is termed a temporary structure, was first erected in the late 'fifties and placed east of the camp near Thorn Hill, close to the Dust Heaps, sandy tracts where the Artillery and the Army Service Corps used to teach their recruits to ride and jump. In thee arly 'sixties, mainly at the instigation of Dr. Edgehill, it was moved to a more convenient spot, viz., to where the Presbyterian Church of St. Andrew now stands, and there it remained until a couple of years ago, when it was pulled down and replaced by the permanent building which now adorns the site.

From its earliest days up to 1893, when St. George's Church was consecrated for the exclusive use of the Church of England, the iron church was used for divine service by Church of England, and Presbyterians, and sometimes by other " Persuasions " as well.

After 1893, the iron church was allotted in the main to the Presbyterians, and it was at their request that, in 1907, the iron church lost its old title and became St. Andrew's Church.

The iron church, where they always worshipped, had a very special attraction for the Aldershot Engineers. They had built it originally, and, later on, had moved it to its new site. A famous Army chaplain, Dr. J. C. Edgehill, later Chaplain-General, was for two periods of service their pastor there. They loved him, and that made them love the more the church wherein he preached. In this way, a succession of officers and men became devotedly attached to the " Tin Tabernacle," unsightly though it was, and many an Engineer Memorial was placed therein.

The iron church found its way into literature, more especially into one of the best known of Mrs. Ewing's stories. There were many heart pangs when, in the fullness of time, the death sentence was passed, and a building hallowed by many a sacred memory ceased to exist.

Williams was one of the many who loved the Tin Tabernacle: he was a constant worshipper there, helped in the choir, and on many occasions played the harmonium at the voluntary services. He had a deep and lasting affection for Dr. Edgehill, and more than once assisted him in the efforts he was making for placing the Chaplain's Department, and all that appertained to it, on a more satisfactory basis.

A counter-attraction to Dr. Edgehill, although not probably one that appealed to Williams, was the Rev. Charles Kingsley, the Rector of Eversley; on Sunday mornings not a few from the camp used to ride or drive over to hear him preach in his little country church, and get a subsequent glimpse of the glories of Bramshill.

The story of Edgehill's first rise to fame was often told the writer by Williams, and just recently, July 1st, 1928, the incident was

referred to by the present Chaplain-General, on the occasion of his unveiling a window at St. George's Church, Aldershot, to Dr. Edgehill's memory.

Edgehill was a man of somewhat High Church tendencies, which were anathema to the then Commander of the Aldershot division. Rumours reached Sir Hope Grant of a Communion Table recently introduced, which was high in two senses of the word. In one of his morning rides, Sir Hope inspected the table, sent for an R.E. carpenter, and had the length of the legs summarily reduced. Edgehill, naturally, was furious; he resigned his appointment, and announced the fact from the pulpit on the following Sunday. The R.E., to a man, were with their beloved pastor, and the camp hummed with excitement. Edgehill stood his ground, the Duke of Cambridge came down to inquire, supported the Chaplain, and was so struck by his qualities that he never again lost sight of him, and in course of time appointed him Chaplain-General.

There was at this time living in the Commissariat Lines, and later, as already stated, in one of the R.E. married officers' huts, No. 3, N Lines, the lady who, by her books, did so much to keep alive the memory of the Aldershot of those days, Juliana Horatia Ewing.

Her husband, Major Alexander Ewing, was for many years an officer in the Army Pay Department. A man of many parts, and a talented musician, his name will always live as the composer of the well-known music of "Jerusalem the Golden." He was a well-known figure in the life of the camp, and for years played the organ in what is now called the Royal Garrison Church of Aldershot, but which was formerly better known as the "Red" Church.

He had great skill as a conductor and accompanist, and as such was indispensable at the various concerts and amateur performances in camp. He was a great friend to all who loved music, as many an officer who relied on his help and profited by his instruction could testify.

The Ewings had a long career at Aldershot from 1869 to 1876, and, endowed with a singular charm, were the valued friends of a succession of Engineers, married and single. He was a welcome member of the R.E. Mess, and in later years was equally at home at the R.A. and R.E. Mess in Malta.

Among their many admirers and allies, a principal place must be given to the Jelf family, father, mother and sons, whose names occur frequently in Mrs. Ewing's letters, and in the Memoir of her written by her sister, Mrs. Eden.

In the pleasant circle of those days at Aldershot Williams had his place, and with his love of music and art, and a kindred outlook on religion, he was numbered among the friends of Major and Mrs. Ewing.

In Mrs. Ewing's books there are numerous references to the camp

and to the Royal Engineers, more especially in one of the most delightful and pathetic of them, "The Story of a Short Life." This book also contains a sketch of a High Church Officer of Engineers, which, the Williams family have always held, was drawn from the subject of this Memoir; to the present writer the likeness seems unmistakable, Williams is drawn to the life. It is hoped that one result of this Memoir may be to introduce some of its readers to a series of delightful stories from the pen of a gifted writer.

His Aldershot days were indeed happy ones for Williams, and he was very fond of talking about them in later years. At Aldershot he made many a friendship, he loved his work, and its surroundings, whilst his soldierly smartness and military efficiency, so patent to all who knew him subsequently, were in no small measure due to his two years' service in the Train.

Chatham.

Williams was promoted to the rank of Second Captain at the end of June, 1872, and so at the close of the Army manœuvres of that year he was sent to Chatham, to take command of the 35th Company, R.E. He was also appointed Assistant Instructor of Fortification, a post which he held for just under a year, going to the R.M. College, Sandhurst, as an Instructor on September 1st, 1873.

The matter which is of chief interest regarding Williams' year at Chatham was his acquaintance with the future Lord Kitchener. A good deal is told in Sir George Arthur's volumes, but the writer got it first hand from Williams on many occasions from 1883 onwards, and long before Lord Kitchener reached his zenith.

The acquaintanceship commenced, as Sir George Arthur describes, by Kitchener bursting into Williams' office, and begging to be allowed to remain on in possession of the room which he had been just ordered to vacate, because it belonged to the quarter which had been allotted to Williams: the latter visited the room, crowded with all sorts of things, including a parrot, took a liking to the impulsive youth with a nice, persuasive manner, and so commenced forthwith a friendship that never ceased till death divided them. Williams joined at Chatham on September 27th, and we find an entry in his diary dated November 17th, "Evening Service at Rainham with Kitchener," and again, "Dec. 15th, Evening Service at Upnor with Kitchener"; as is said in Sir George Arthur's book, "In a week we understood each other, took our daily exercise in company, sat next each other at Mess, went to evensong together, and became inseparable."

From all accounts, the Kitchener of those days was not of much account among his contemporaries: probably because, unlike most of them, he never had a public school education, or acquired the public school attitude to things in general: he was more natural and outspoken than his fellows, and it was only later that he learnt, as it

were, to wear a social mask to face the world with. But Williams was at once struck by the qualities of " John " Kitchener, as in those days he used to call him, and was the first in the army to appreciate the potentialities of the future saviour of his country: it was a remarkable bit of character reading, and a testimony to Williams' insight. One story which Williams often told me was how on one summer's day in 1873, " John " Kitchener came to him with an application to be allowed to attend the *manœuvres* in Austria, which were to be held that autumn; it was a strange thing for a young officer at Chatham to know anything about foreign manœuvres, and stranger still for him to imagine that he might be allowed to attend them. Williams explained to the impulsive John how useless it would be to send forward such an application; Kitchener, however, was persistent, and to please him, Williams backed the application, never imagining that it would even reach the War Office. The unexpected, however, happened, for not only did the request reach Headquarters, but in due course instructions came from London that " John " was to accompany a General Officer to Vienna. The story went on to say how the General fell ill on arrival at Vienna, and how frightened " John " was when the Military Attaché told him that he would have to sit next the Emperor at dinner—how Francis Joseph at once took to the lanky, eager boy beside him, helped him in every way, made him ride with him in the field, and how, when the manœuvres came to an end, the Emperor told Kitchener that he must never pass near his dominions without coming to Vienna to see him. The story shows the Emperor was no mean judge of character, and he shared with Williams the distinction of having " discovered " Kitchener years before he began to make his name. It would be interesting to know whether, forty years later, in the Great War, the old Emperor ever told the story of how he first met Kitchener.

In after years, Williams always spoke of his friend " John " in the terms of the greatest affection: his faith not only in his professional future, but in his sterling worth and the deep religious basis to his character, never altered.

Kitchener was posted to " C " Troop at Aldershot shortly after Williams became an Instructor at Sandhurst, and they collaborated over the improvement to the iron church: we read in Williams' diary of the dedication of the organ, on the same day that " John " said " good-bye," prior to joining the Survey of Palestine.

Kitchener never forgot the friend of his Chatham days, and always kept up with him, wrote him frequent letters, and, long after becoming famous, paid him many a visit at the Findon cottage.

The scene now changes to the Royal Military College, Sandhurst.

During his period of ten years at the College, Williams came under three Governors, Generals Sir Duncan Cameron, William Napier and Sir Richard Taylor.

He served for 8½ years as Instructor under two professors of Fortification, Colonel G. Philips, followed by Captain E. C. O'Brien: he was professor for only eighteen months, and on leaving was succeeded by Major L. K. Scott, famous in rackets and cricket, and the inventor of the telescopic sight.

The cadets were organized at that time in divisions, very much the same as a company, and Williams was one of the six Instructors who lived in the College, where he commanded No. 5 Division. In this way, he was brought into very direct contact with those in his Division, over and above those in the classes which he instructed in fortification. Williams was known to successive generations of cadets as "Pie Bill." The name did not arise because he evinced any desire to approach cadets on religious topics, but rather because he showed in many ways how religious he was. It is not easy at a glance to tell a very devout Low Churchman, but it is different with the school to which Williams belonged, and anyone making the sign of the Cross at grace, as Williams always did, would be at once noticed by boys, and it was doubtless to the various signs of reverence, which a High Churchman adopts, that Williams owed his nickname.

A former Cadet, who knew him well, writes as follows:—"His "genuine piety was known and respected by all of us, even by those "who were themselves irreligious. It was evidently so perfectly "genuine, and at the same time unobtrusive, that he was always "spoken of with something akin to affection. His nickname was "'Pie Bill,' but his piety never aroused the opposition and dislike "which is often the result of the tactless and over-zealous introducing "of religion when it is not desired. He was wise enough to be friendly "and natural with cadets, to enter into their interests and amuse-"ments, and to wait for opportunities of speaking on religious and "moral questions. When such opportunities arose, he went straight "to the point, and anything he said was listened to and remembered. "As an illustration of his method, I recall the case of a wild young "Irishman in his division, who was in hospital suffering from venereal "disease. Williams went to see him, and spoke very seriously to him "on the whole question of the other sex. That this young fellow "was not vexed or annoyed or contemptuous, but told me with no "feeling of resentment all that Williams had said to him, surprised "me much at the time, and I have always remembered it as an "illustration of his courage and his wisdom.

"He had a knack of getting to know many cadets not in his "division, who religiously or morally were a little above the ordinary "level. We used to go to tea with him in his rooms, and sometimes "go up at night, and sit talking and smoking with him. He was, "as you know, a great smoker, and nothing of a pussyfoot, two things "which helped to endear him to us, and made for friendly conversa-"tion. I do not remember that he ever introduced religious questions

"on those evenings, but he got to know our characters, and so to "know what he could say properly and without offence, when anyone "of us was alone with him."

It may be mentioned that the writer of the preceding interesting note first got to know Williams through devotion to games and athletics, at which he was a great proficient, because it illustrates what has been previously written about the attraction which skill at outdoor pursuits had for Williams.

Another cadet to whom Williams was devoted, now Lieut.-General Sir Thomas Snow, accentuates the tact displayed in not forcing religion on unwilling cadets, and writes: "I cannot remember any "instance when I was aware that 'Pie Bill' was thrusting religion on "one. I do remember that he used to get some of us to go to evening "service on Sundays, but he did it so well that I am not sure that "we did not think that we were taking him."

General Sir Archibald Hunter, who was a Sub-Lieutenant at Sandhurst in Williams' early days, viz., in 1874, writes as follows of him:—"He was a dear, good friend to us boys at Sandhurst, and "helped us in every way, not only with our work, but with our whole "life and thought. I have never met any officer in the army who "was more trusted, respected and beloved, than Major Williams. I "have a photograph of him among my treasures. He was a great "gentleman, a sincere Christian, and was a perfect model of what "we should all try to be."

It seems full of interest that Williams should have made, independently, such an impression at the very outset of their careers on Lord Kitchener and Sir Archibald Hunter, who were destined to work so much together, and to make such a mark on the history of our times.

There can be no question as to the deep and abiding influence for good which Williams exercised during his ten years at Sandhurst on a great number of young men at the most impressionable period of their lives; amongst these were many who subsequently rose to high distinction, and who have been ever ready to acknowledge the debt they owed to "Pie Bill." In his later years, Williams always spoke of his time at Sandhurst as the happiest and most fruitful in his life. The present writer himself has received abundant personal testimony as to what Williams achieved among the cadets, and in almost every case where he has come across in later years a Sandhurst friend of Williams, he has seemed to find, in a very nice and generally athletic fellow, something still remaining of the Williams 'touch.'

No mention of Williams' work at Sandhurst would be complete without a reference to the share he took in the internal decoration of the College Chapel.

The chapel, which was dedicated in 1879, was modelled in design on a church in Florence; built of brick, the design lent itself to a

scheme of internal decoration of coloured marbles, on lines familiar in Italian architecture, and with special reference to the Cathedral of Siena. A scheme to this end was drawn up by Williams, and received approval.

There were to be at intervals special war panels of Derbyshire alabaster, inscribed in letters of gold, with the names of all those who had passed through the College, and who had lost their lives on active service.

At a higher level than and between the war panels, circular alabaster tablets were placed, with the names of past governors of the College. Above, below and around the war panels and the circular tablets, the walls were covered, as a commencement, to a height of about ten feet, with different marbles of varied colours, arranged in beautiful patterns, and with varied ornaments.

The scheme provided for the gradual decoration of the church on these lines, and its effect bore some resemblance to the internal decoration of the Guards' Chapel at Wellington Barracks, which was taken in hand about the same time.

Ten of the war panels were completed with the names of those who fell in campaigns from 1854 to 1890, and those who remember the chapel as it was, up to the outbreak of the South-African War, bear testimony to the beauty of the design, and of its effect when completed.

After the South African War, fresh arrangements had to be made for causes which need not be particularized, and the original design of decoration was not followed in its entirety. Later on, when the number of cadets in the College was largely increased, it became necessary to enlarge the chapel: the work was taken in hand after the Great War, and has not yet been completed. The method of internal decoration was changed to meet a new situation, with the result that the work which Williams initiated is only to be found in portions of the earlier building, and especially near the vestry door.

In the parts that remain of Williams'-work, it will be seen that the names that were once coloured in gold, have been changed to brown. This was the result of action by the late H.R.H. the Duke of Cambridge, who at his various visits to the chapel did not like the gold lettering, because the names could only be read on close approach. This had been well appreciated by the designer, the gold harmonized with the marbles of various colours in the general scheme of decoration, and the last thing he desired was that the names should catch the eye, and distract the attention of the congregation. The Duke at last had his way: one day he visited the chapel with Sir Redvers Buller, and again commented on the fact that he could not read the gilded names from the centre of the church, and once more expressed the opinion that they should be painted black. Sir Redvers Buller, the writer is glad to know, opposed the suggestion of H.R.H., but

when some ladies, who were present, came forward, and offered themselves to paint the names in black, royal and feminine pressure in combination proved too strong, and the dark deed, which from an artistic point of view was wholly indefensible, was put in hand.

On completion of ten years' service at the R.M.C., Williams, then a regimental Major of four years' standing, reverted to Corps duty.

A tendency to deafness had been coming on gradually during his Sandhurst years, and Williams, keenly sensitive in such matters, had doubts whether he was justified in continuing longer in army service. He consulted Sir Howard Elphinstone, then at Aldershot, on the subject, who, in the course of his reply, wrote—"As to your "slight deafness interfering with your work, I am satisfied that "this idea exists in your mind only and in no one else's! You "are in every respect more able to perform your work than 99 out "of 100 in our Corps, and I trust that you will drive such ideas from "your head as a duty which you owe not only to yourself but to the "Corps. We cannot afford to lose an officer of your stamp."

Fortified by such an opinion, Williams found himself ordered on Corps duty to Egypt.

He went in the early days of the occupation, and there was still a considerable British force of all arms in the country. General Sir Frederick Stephenson had just taken over command, an Engineer, Sir Gerald Graham, V.C., commanded the Infantry Brigade in Cairo, whilst General W. Earle had charge at Alexandria.

Williams found his old friend, Sir Evelyn Wood, as the first Sirdar, engaged in bringing into being the Egyptian Army: Kitchener was Second-in-Command of the Egyptian Cavalry, and Hunter had command of the Sudanese Battalion, which became so celebrated under him in stress of war. Sir Evelyn Baring, afterwards Lord Cromer, held sway at the Residency, and the disaster at El Obeid to Hicks Pasha, from which so much was to result, had recently occurred.

Colonel Heriot Maitland was C.R.E., with Captain A. O. Green as his Brigade Major, and the 17th and 26th Field Companies were at Abbassia and Cairo respectively.

Williams joined the R.E. Mess at Kasr-el-Nil Barracks, Cairo, on his arrival in Egypt, and when the writer came to Cairo shortly afterwards, he found Williams settled down, exercising a mild despotism over the Mess, but beloved by all its members. Some of us had got rather slack in our dress at Mess during the summer heat of Cairo, and Williams brought us back to better ways; he gently corrected our shortcomings, and raised our moral standards without any obvious effort: it was simply himself, his personality and example, that did the work. Then he helped to make Egypt, its history and its treasures, interesting to us, and visits with him to the mosques, the churches and the Bulak Museum, were instructive and

delightful: he saw so much, had read so much, and had such a knowledge of art. The young officers at Abbassia and at Cairo were devoted to him, and many of them have confessed the lasting debt that they, like the writer, owe him for developing their tastes, and giving them a higher and better outlook on life. He was so friendly and brotherly to all, whatever their point of view, that he won everyone's sympathy and regard. He was in Cairo when General Gordon passed through on his last journey to Khartum. Williams had known Gordon well, and told us much about him, and he sent us to leave our cards on the General at the Sirdar's House. We never saw Gordon, but the writer well remembers the nice letter Williams had from him, expressing regret that he was unable to come and see his brother officers before he left for the south.

In February, 1884, disturbances in the vicinity of Suakin led to an Egyptian force, under Valentine Baker, being sent there, and, when that was overwhelmed, a hurriedly collected British Force was sent to Suakin under Sir Gerald Graham, and had severe contests with the Hadendowa Arabs at El Teb and Tamai. Williams was the senior regimental Major, R.E., in Egypt, and assuredly would have been sent with the Force as C.R.E. but for his deafness, which had materially increased since he had consulted Sir Howard Elphinstone about it. As a result of this infirmity, Colonel Ardagh, then on the staff at Cairo, but junior regimentally to Williams, was given the post of C.R.E., and Williams was left in Cairo. The decision in the circumstances was perhaps a right one, but Williams felt it keenly, although to us he never showed his mortification, and the writer remembers how helpful he was to those of us who formed part of the Force, and what wise advice and counsel he gave us. The incident, however, brought Williams' military service to an end; he felt that if he was not fit to go on active service, it was better for him to leave the army, and so his papers went in, and on May 27th, 1884, his military career came to an end, when he retired with the honorary rank of Lieut.-Colonel. He travelled home by Venice with one of the young brother officers who appreciated him most, and who has told the writer what a revelation it was to see the beauties of Venice in company with one who was so well able to appreciate and explain them.

Although Williams' life after retirement covered the same span, 43 years, as the previous period, it can here be only very briefly sketched.

He lived for 27 years, from 1885 to 1912, in the cottage at Findon which his father had originally bought.

Here he had as his companion his invalid sister, to whom he was devotedly attached, and of whom he took the most loving care until her death in 1911. He led a very quiet life, but did much unobtrusive

good in the little Sussex village and its vicinity, and had a very attached circle of friends. When first he came home, he was much at Muntham Court, where Lady Bath lived: she had in her day taken a prominent part on behalf of High Church principles, and she and Williams had a similarity of outlook on all religious questions. Her death was a sad blow to him when it came in 1892, and he mourned her " as the truest and best of friends for over 30 years."

As the years went on, his deafness increased, and cut him off more than ever from general society: on account of this, and of the constant care which his sister required, Williams rarely left home. He enjoyed, however, the occasional visits of old friends, whilst he kept up with them and others by means of correspondence. His nephews were devoted to him, and frequently came to see him and his sister as long as the latter was alive. In 1912, shortly after the death of Miss Williams, a move was made to Dorchester, where one of his nephews was then residing.

Williams lived in lodgings at Dorchester until a couple of years before his death, when he moved to Taunton to be near the same nephew, who had finally settled down hard by in Somerset.

At Dorchester he collected more friends, and throughout the War and afterwards was a constant visitor to the Military Hospital, and was happy in helping as best he could those who stood in need of help.

Many stories of his unfailing kindness to the cripples of the War could be told if space permitted.

The evening of his life was wonderfully calm and serene: the writer several times visited him in his lodgings at Dorchester, where he lived in a very modest, simple way, and necessarily to a great extent alone. The dear old man was always bright and happy, and no one who was much with him could doubt that his was the peace that passes all understanding. His final days were spent at his nephew's home.

His mind gradually failed, and he lived over again his early years, and was constantly wanting to get back to Chatham, for fear of overstaying his leave. Then he had constant visits from father, mother, sisters and friends, had long conversations with them, and could never understand how his nephew had never seen or heard them. And so he gradually wore away to the Land of the Leal, reaching it quietly in his sleep in the early morning of Dec. 13th, 1927—and so another " Saint of God " went to his rest.

H.M.L.

December 7th, 1928.

BOOKS.

THE AMERICAN ENGINEERS IN FRANCE.

By WILLIAM BARCLAY PARSONS, D.S.O., Colonel of the Eleventh U.S. Engineers. (D. Appleton & Co., New York and London. 1920.)

It is much to be regretted that the existence of this useful book, published in 1920, was almost unknown in this country until its author presented a copy to the Imperial War Museum in 1928. It should find a place in every military library, because it contains information in a very readable form which will interest not only the military engineer but also the staff officer who has to study the problems of organization and equipment of an army in the field.

The author deals with almost every kind of work with which Engineers are concerned in modern warfare. He did not intend the book to be a history, or to give a detailed account of the work done by the American Engineers in France. He wrote primarily in order to give those who did not go overseas a picture of what is meant by engineering in a modern war. "Military engineering"—he writes—"consists in doing things "in the simplest and quickest way, where permanency in character and "accuracy in execution yield to the imperious demands for results that "are immediately available regardless of all other considerations." To those who did not have the opportunity of seeing the American Army at war, the book will be of special interest, and will give them some idea of the immense achievements of the American Engineers behind the line, which enabled the American Army to take the share it did in the autumn campaign of 1918.

The engineering subjects with which Colonel Parsons deals include :—The new military engineer—military and civil engineering; Franco-British engineering problem; America's problem; Engineer organization; Organization of engineer troops in the field; Engineer organization and engineer work in the U.S.A.; Base ports, and their development and control; French railways; American railway operations in France; Storage yards and other railway construction; Forestry; Water supply; Tunnelling; Gas; Camouflage; Maps; Flash and sound ranging; Searchlights; American artillery, and railway guns; Light railways; Roads; Trenches and trench warfare.

Under each of these headings the author not only describes generally what the Americans did, but he prefaces each account with a brief description of the methods and organization adopted by the British and French armies as a result of the experience of nearly three years of war, and compares them with the system adopted by the Americans.

The Americans were fortunate in being able to reap the fruit of the experience gained in 1914–1917 by the two great Allied armies, and they were quick to grasp the good points in each system and adopt what was most suitable to American practice and character, once they were convinced that their own system was unsuitable or capable of improvement. They had just been at war themselves, for nearly three years, on the Mexican border. Before joining the Allies they had already realized that what was sufficient for Mexico would be wholly inadequate in Europe, and they came to France with open minds. A great responsibility, therefore, fell on the shoulders of men of the type of the author of this book, who accompanied the first troops—Engineers—of the American Army to land in France. They were big men with big ideas, and lost no time in putting those ideas into practice. The American Army owed much to the breadth of view of its pioneers in the "invasion of France."

Not the least interesting chapters of the book are the two entitled: "The American 'R.E.s'" and "Relations with the French." In the former, as the title indicates, Colonel Parsons writes in the warmest terms of the very friendly relations that existed between the Engineer battalions, which were the first American troops to arrive in France, and the units of the Corps of Royal Engineers alongside of whom they served. He was deeply impressed by the sterling qualities of the British soldier, and lays particular stress on the relations between the British officers and their men. "They (the Americans) saw"—he writes—"that the "British officer, in spite of an assumed indifference, cared for his men as "the officers of no other army did; they saw in him one brave to reck- "lessness, they knew that he never ordered his men to do what he would "not do himself. These qualities naturally won the full respect and "implicit confidence of the men, and established between officers and "men a mutual respect that won the admiration of the observer. . . It "is a pity that more American units could not have served with the "British forces, but it is hoped that enough did so to lay the foundations "of a fuller understanding and a better feeling among all branches of "the English-speaking race."

Colonel Parsons was a shrewd observer. In his appreciation of his French comrades-in-arms, he admits that the Americans were totally unprepared for the calm self-control not only of the French soldier, but also of the nation as a whole, and pays tribute to the conduct of the women of France in the midst of danger and the destruction of their homes and country.

Other chapters deal with engineer work in conjunction with the British in the Cambrai offensive and defensive: and the St. Mihiel offensive. The concluding one is devoted to statistics—useful and instructive to us, and indicative of the methodical thoroughness with which Americans are accustomed to compile statistical data relating to their enterprises in war and peace, a trait in their character traceable to the strong Teutonic element settled in the Middle West, which during the last fifty years has had such an influence on the development of the modern American citizen.

H.B.-W.

THE LAKE PLATEAU BASIN OF THE NILE.

By H. E. HURST.

Parts I and II. CAIRO MINISTRY OF PUBLIC WORKS.

(Price 6s. 6d.)

These two Reports are the result of two missions by Dr. Hurst; the first in 1924, the second in 1926.

The plan shows the ground covered by the two journeys. 1,050 miles were done on foot or bicycle in the first journey, and 2,260 miles in the second.

Naturally, much geographical information was collected and detailed descriptions of rivers and geographical features, of natives, of animals and insects fill several pages of the Report; and very interesting photographs give an excellent idea of the type of country.

The object of the journeys was to acquire further information on the physiography, hydrology and climatology of the Upper Nile Basin, and so to co-ordinate existing knowledge on that area.

Nile Control, published in 1920, outlines various works, suggested several years before, to be carried out on the Blue and Upper White Niles, essential to increase the irrigation of Egypt: and so provide cultivated land for her increasing population.

The real problem is how best to develop the enormous resources of the Blue and White Nile waters and to irrigate new areas of land in Egypt and the Sudan or to improve the irrigation of land already cultivated.

Both Niles are equally important to Egypt. The Blue Nile provides the Nile flood: the rains of Uganda and Tanganyika contribute largely to the low stage supply of Egypt.

This low stage supply is quite insufficient and schemes to increase it make it essential to study the climate and physical conditions of the Lake Plateau Basin. To develop the cultivable area of the Nile Basin to its fullest extent, water must be stored from the flood to increase the supply of the low stage, as is done by the Assuan Dam, and further, water must be stored in years of good supply to cover deficiency in bad years.

The latter is only possible in the Great Lakes, where a rise of level does not increase greatly the water losses, and where a small change of level implies a large volume of water impounded or released.

Also to make a programme for summer irrigation, one must forecast the low stage supply, and hence one must study the physical facts whence that supply comes. The Reports contain data showing the mean annual rainfall gauge readings at various places, and discharges of the various lakes and rivers flowing into them.

Briefly, the Rift Valley, or Albert Lake system has an area of 53,000 sq. kilom., Lake Albert's share being 5,300 sq. kilom. The area of land basin draining to Lake Victoria is 193,000 sq. kilom.: the area of Lake Victoria is 69,000 sq. kilom.; while the total area of Egypt that can be cultivated is only 30,000 sq. kilom.

The quantity of water received by the Lake Victoria is about 100 milliard cubic metres per annum, or 40 times the amount stored by the Assuan Dam.

Evaporation on the Lakes probably equals the rainfall on those Lakes: but over the swamp areas possibly evaporation and transpiration from the vegetation exceed the rainfall. The run-off of water from the various basins can only be very roughly determined.

Discharges of the various rivers and lakes have been roughly determined but much requires to be done to improve existing knowledge, and this must be spread over a series of years.

The following is a summary of the hydrological information:

Mean annual rainfall in Lake Victoria Basin ...	1,190 mm.
,, ,, ,, ,, Lake Kioga Basin ...	1,300 mm.
,, ,, ,, ,, Lake Albert Basin ...	1,380 mm.
Annual evaporation from Lake Victoria ...	1,300 mm.
Mean daily evaporation from Lake Victoria ...	3·6 mm.
Mean discharge out of Lake Victoria over Ripon Falls	640 $m.^3$ per sec.
,, ,, out of Victoria Nile entering Lake Albert	670 $m.^3$ per sec.
,, ,, of Albert Nile out of Lake Albert	840 $m.^3$ per sec.

The changes of level of Lakes Victoria and Albert agree fairly well with the estimated figures of the factors which affect those changes: *i.e.*, rainfall, evaporation, run off and outflow.

Thus, in the case of Lake Victoria:

(1)	Rainfall on the Lake per annum	1·260 metres.
(2)	Add run-off from the Lake Basin distributed on basis of rain of S. part of basin, allowing 15 days' lag ...	·330 metres.
(3)	Discharge over Ripon Falls 640 $m.^3$ per sec. gives 290 mm. if spread over the Lake	·290 metres.
(4)	Evaporation	1·310 metres.

Thus, on Lake Victoria, evaporation and direct rainfall are nearly four times as important as run-off from the remainder of the basin and outflow.

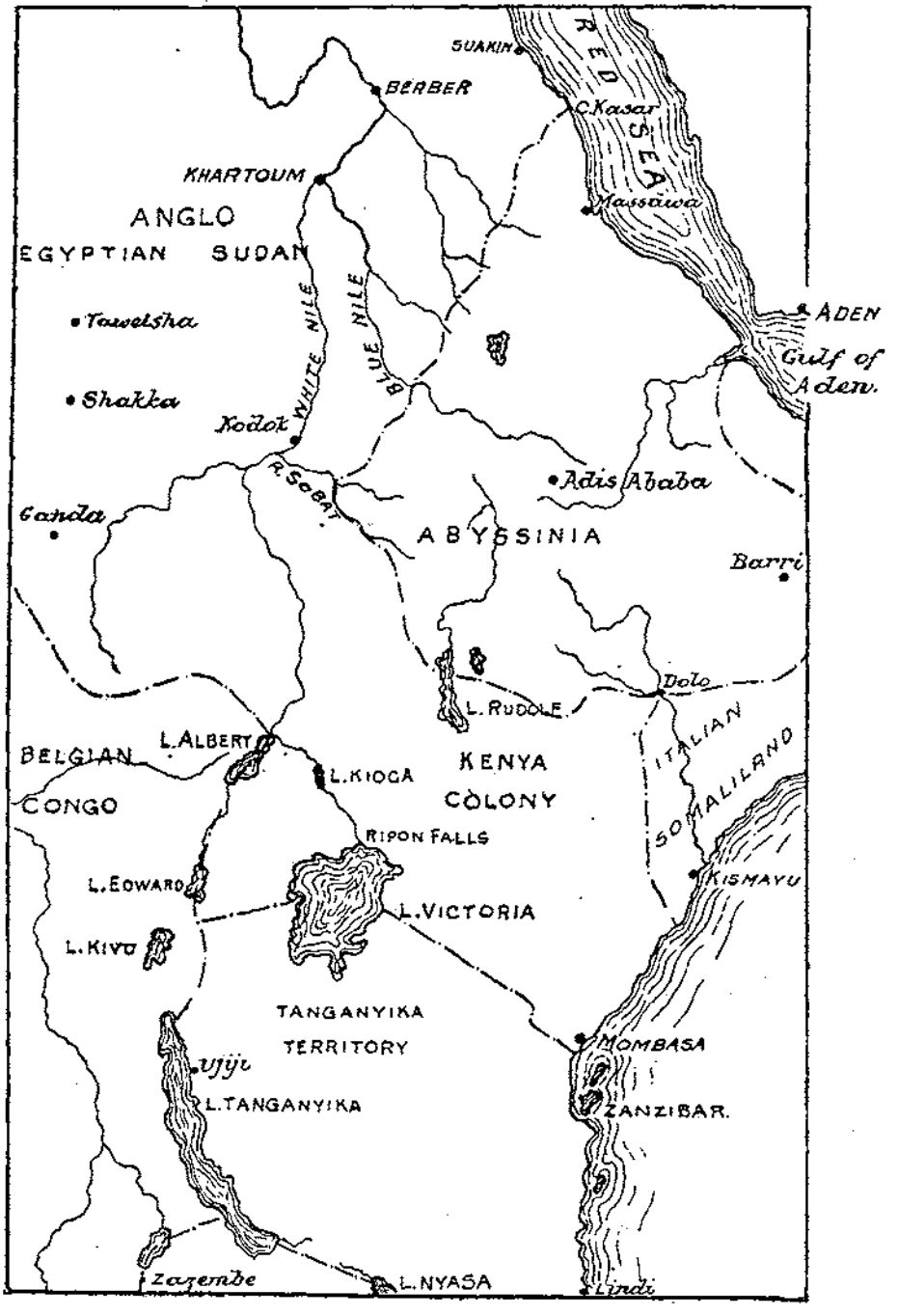
The inflow from Lake Victoria into Lake Albert is about twice the run-off from the catchment area.

The outflow by the Albert Nile is 25 per cent. greater than the inflow from the Victoria Nile.

To give quantities for Lake Albert:

	Million metres.
Run-off, including Victoria Nile inflow ...	4,500
Rain on Lake Albert (1,380 mm.)	2,400
Evaporation on Lake Albert	2,600
Outflow to White Nile	4,300

THE LAKE PLATEAU BASIN OF THE NILE.



These figures show the importance of evaporation. The Rift Basin has mostly mountain streams and few swamp areas. The Victoria system includes large areas of swamps and many of its streams are swamps. Obviously, these lakes and swamps are responsible for huge losses of water by evaporation. They require much further investigation and survey. Surely there is wide scope here for air survey at regular intervals: to show increase or decrease of vegetation and of water levels.

The growth of papyrus is perhaps the most important hydrological factor both for navigation and for irrigation. Hence early study of the habits of swamp vegetation is important.

Topography, survey, and levels can be taken once for all and quickly. River discharges, varying water levels, and rainfall figures require years for the collection of reliable data: hence the following are advised:

(1) The measurement of quantities of water passing all the principal points.

(2) The meteorology of Central Africa and allied regions.

(3) A study of the salinity of the lakes.

(4) Collection of all hydrological information for all remote parts of the Nile Basin.

During the time of shortage of water in Egypt, about 50 per cent. of the total supply of the Nile comes from the Equatorial Lakes.

By regulating these Lakes, the supply of good years can be made to augment the supply of bad years. Much information spread over a series of years has yet to be collected to enable full value to be made of these resources.

The Reports, of course, give much detail of these facts and figures, showing how they are derived; and it is not so dry as the above would indicate.

The study of the figures themselves is not uninteresting and to think out what use can be made of them by making dams, raising lake levels, or cutting sudd regions or improving river gradients is very fascinating.

The photographs add greatly to the interest of the book and the accounts of the country passed through are of value to future travellers; while Professor Schwarz's theory that the waters of the Lake Victoria will some day flow into Lake Tanganyika or the Congo will not worry any generation for thousands of years to come, if ever, according to Dr. Hurst.

In addition to the geographical interest given in these Reports, there are appendices on salinity of the waters of the lakes, methods of discharge, measurement, and a note on the Mbuga soils of the Lake Plateau region and the alluvia of the Kagera River.

S.F.N.

A DISTINGUISHED CHIEF ENGINEER.—THE LIFE OF JOHN MONTRESOR.

By J. C. WEBSTER, F.R.S.C. (Transactions of the Royal Society of Canada—a Presidential Address. Ottawa, 1928.)

The subject of this sketch was born of Huguenot extraction in Gibraltar on April 6th, 1736. He served as an assistant engineer under his father, James Gabriel Montrésor, who was himself a Colonel of Engineers, for four years, and in December, 1754, went to America with General Braddock as an engineer, holding the rank of ensign. In the battle of July 9th, 1735, in which Braddock was defeated and killed, John Montrésor, who had just been made a lieutenant in the 48th Regiment, was wounded. During 1756–57, he was employed as an engineer at Forts Edward and William Henry. In 1758, he served as an engineer at the siege of Louisburg, acting under the Engineer Director, Colonel Bastide, and the Sub-Director, Major McKellar. Later, he served throughout the siege of Quebec. After continuing to serve in Canada to the end of the Seven Years' War, and then in the wars against the Indians, he went home in 1767, and was given a warrant as Chief Barrack Master of the Ordnance for North America. He immediately returned to America, and was employed in various parts of the Colonies. When the Revolution broke out he was in Boston, and was with Lord Percy during the Battle of Lexington. He became the principal engineer in the army, and served on till 1778, when his health broke down and he returned to England. Soon after he was made a colonel and retired, taking up his residence at Belmont, in Kent. He died in his London house in Portland Place on June 26th, 1799.

"Of the many distinguished British officers who served in America "during the second half of the eighteenth century, it is doubtful if any "had a more varied or more interesting career than John Montrésor. "He was a man of strong character and great determination, performing "his duties with energy and enthusiasm. He had a keen and critical "mind, and his abilities were manifested in varied directions. As a "military engineer he stood in the highest rank. As a surveyor he had a "most extensive experience. . . . One of the very best portraits of "James Wolfe was made by him at Quebec on September 1st, 1759, "and was probably the last made of the General in life; it was afterwards "engraved in London. His many journals and reports indicate that he "had exceptional powers of observation, and the gift of terse expression. "His journals of the sieges of Louisburg and Quebec are interesting ". . . and those dealing with the operations during Pontiac's War and "during the Revolutionary War are of the greatest value. He could be "severely critical and unsparing in his words of detestation for those "whom he disliked or despised. He hated General James Murray, "under whom he served at Quebec after the capture, and refers to him "as a 'tyrant' and a 'madman.' On Clinton he poured forth his scorn "in a page of Spanish and French. He expressed fierce resentment at "the rewards and promotion of other officers, when he felt that his own "services had not been sufficiently recognized.

" He backs up his pretensions to preferment by referring to the military " services of his ancestors, to the commissions which he purchased for " his sons in their army careers, to the loss of two brothers in the service, " to the death of his father, ' who,' he says, ' broke his heart in his " Retreat, for being neglected and deceived by His Majesty's Deceitful " Servants.' Finally he refers to his wife and her family as follows : " ' My wife lost her father and a brother in its cause, and her numerous " relations are reduced from Opulence to Poverty for their Loyalty and " attachment to the Crown of Great Britain.'

" In the later years of his life he recorded his criticisms of the military " operations of the British in the Revolutionary War, and gives in his " frankest manner his reasons for their ill-success. These may be com- " mended to all students of the period, making full allowance for his " personal prejudices and antipathies, impartial readers must admit the " reasonableness of many of his views, whether they refer to adminis- " trative errors in England or to the actual conduct of affairs in " America."

One of his greatest grievances related to the failure to grant proper rank to Engineers. " Though he had served 28 years in the Army, of " which 24 had been spent in America, and though he acted as Chief " Engineer, he was only a Captain when he retired in 1778. Indeed, at " this time Engineers were in a peculiar position. They were scarcely " considered as belonging to the military caste. They did not gain pro- " motion by seniority, nor were they given rank in the regular manner. " Usually they were designated as ' Mr.' When rank was granted by " the King, it was considered as an honorary title.

" Among Montrésor's papers is an admirable presentation of the " anomalous situation relating to Engineers in the Army, with a strong " plea for reform, calling attention to their much higher status as regards " rank in various European countries. His closing paragraph reads as " follows :—' It's rather extraordinary that in a country where the Arts " and Sciences are so much encouraged that a scientific body, and of " so important a nature that the very Defence of the Realm depends " upon, should be so totally neglected.' It was many years before the " Engineer Corps was established on its present basis."

H.B.-W.

OFFICIAL HISTORY OF AUSTRALIA IN THE WAR OF 1914-18.

Volume IX.—The Royal Australian Navy. (Angus & Robertson, 89, Castlereagh Street, Sydney. 21s.)

This volume of the series contains 649 pages, with 90 photographic illustrations and 28 maps, and has been placed in the R.E. Corps Library at the Horse Guards, together with the other volumes of this series already received.

A SHORT ACCOUNT OF CANTEENS IN THE BRITISH ARMY.

By The Hon. Sir John Fortescue. (Cambridge University Press. 3s. 6d. net.)

The historian of the British Army has again placed those who are interested in his subject in his debt. Many a young officer, and many an old one for that matter, forgetful of the curse pronounced against the Serpent after his adventure with Eve, has said he would do this or that till brought up short by the pronouncement of "Q," who simply says "you can't." This book of seventy-nine pages does not deal with the more spectacular, and, to most, the more interesting side of the Art of War, but with the Organization which in peace and war supplements the official ration, and helps to provide that degree of comfort and sustenance for the human machine without which all the best-laid plans of "G" are of no avail. From the earliest days of organized warfare, armies in the field have been accompanied by private adventurers selling foodstuffs to the troops. So necessary to the welfare of the armies were these traders that they were soon officially recognized and regulated. In the British Army these gentry were termed sutlers, and during the fighting in Flanders under Marlborough, the Commissary supplied bread only, and for all other supplies the troops were dependent on the sutlers. It is rather startling to be made to realize that in Britain, apart from a few fortresses like the Tower of London, there were no barracks for the soldiers to live in before the very end of the eighteenth century. The men were billeted in ale-houses, "whose landlords were required under the Mutiny Act to provide them at a fixed tariff per man with food, fire, and candle." It also helps one to get things in their right perspective to remember that, in a gradually lessening degree till the old system finally disappeared in 1871, "regiments were the property of their colonels, and troops and companies of their captains, all of whom enjoyed considerable independence. The Army, in fact, was not an army at all, but a collection of regiments. The welfare of the men depended entirely upon the regimental officers, and we shall presently see that all the improvements in their condition have been originated by regimental officers."

During the eighteenth century, troops stationed abroad were fed practically as they would have been at sea, on salt provisions, and for the rest they lived as best they could, or died. For wars on the Continent, contractors were always forthcoming to act as sutlers up to the time of the war in Spain. In India, too, there was no difficulty, but in the American continent it is not known really what arrangements it was possible to make during a campaign. During the war in Spain and Portugal, no contractors were forthcoming, and the Commissariat had to do the whole of the contractors' work for themselves. Wellington had to build up a completely new system to meet this need, and it took three years for the Treasury to grasp the fact that they were up against new conditions. From the time of the Battle of Waterloo till the Crimea, three out of every four line battalions were abroad and generally fighting. During this time, as a result of the building of regular barracks at home, it had been decided, as the less of two evils, to allow spirits to be sold in a

canteen within the barrack area: other articles were added later, but the quality of all that was sold was poor and the price high. The State, however, made some £53,000 a year from the contractors (really from the troops) as rent for the canteens. The system was gradually improved upon by the regimental officers, who provided the means for the privates to obtain cheap suppers, started libraries, or even formed theatrical companies from among the men. From 1836 onwards, "the State began from very shame to learn from the officers, and in 1847 it was openly proposed in the House of Commons that the existing regimental canteens should be replaced by coffee-rooms, and that the profit arising therefrom should be devoted to the upkeep of reading-rooms and other institutions for the soldier's benefit." The Crimean War was followed by many administrative and other changes in the Army, and by the new canteen regulations of 1863 "the canteen was established as a regimental affair. The commanding officer selected a canteen committee, consisting of a president and two subordinates, and purchased his goods for the canteen in the open market from any tradesman or tradesmen selected by the Committee." The abolition of long service about 1870 meant that the character of the Army was radically changed. The long-service man had inherited traditions of hard drinking, which disappeared more and more with the change in the character of the recruit.

In 1894, Major H. J. Crauford, of the Grenadier Guards, Capt. Lionel Fortescue, of the 17th Lancers, and Surgeon-Captain H. M. Ramsay, medical officer attached to the Scots Guards, founded a co-operative society, known as the Canteen and Mess Co-operative Society, the object of which was to obtain for regimental canteens dealing with them supplies of a good quality at a reasonable figure. The capital was £400, and the interest thereon was limited to five per cent. In spite of "fierce competition from the firms which had enjoyed the monopoly of canteen business, its trade steadily increased. In 1896, the Society moved to much larger premises in Regency Street, Westminster; and very soon Captain Fortescue, enlarging upon Major Crauford's original idea, conceived of a plan by which he hoped to place the Society upon a much stronger footing. This was that the customer-regiments should gradually buy out the individual shareholders, making the Society their own; that eventually the whole Army should be included, and that the Society should be the whole Army's Co-operative Society, conducting its own business for its own officers and men, and distributing the profits, both wholesale and retail, among them without any official interference whatever. The scheme was derided by most officers as an idle dream, but Captain Fortescue never lost faith in it." We have no space to trace out in this notice how this dream was eventually realized; it must suffice to give two more quotations from our author. Speaking of the founding of the Navy, Army and Air Force Institute on the 1st of January, 1921, he says, "Thus at last the co-operative principle was accepted as that which should govern the canteen service. In 1863, canteens had been made the subject of contract, and for 50 years that system had been accumulating the steady pile of damnation which reached its climax in the canteen scandal of 1914. The co-operative principle had been initiated (as may be once more repeated) in 1894. Lord Gray's Committee had recom-

mended its adoption in 1902, but in vain. Four more committees in 1914, 1916, 1920 and 1921 upheld it; and it is interesting to note how many committees are necessary to break down a system which has been abundantly proved to be vicious. But in truth it was not the committees, but the astounding work of the E.F.C., itself the offspring of the Canteen and Mess Co-operative Society, which fairly compelled the formation of a similar permanent organization for the fighting services, not only in time of peace, but, if fate should ordain it, also in time of war."

And again: "To the present writer, who has followed the life of the British soldier closely through the centuries, the establishment of the N.A.A.F.I. presents itself on the whole as the greatest benefit that has ever been conferred upon the Army. As an ordinary householder he greatly envies the officer, soldier and their families, who are privileged to take advantage of it. Had they any conception of what their predecessors had to put up with, they would cherish it to the uttermost. But man is a suspicious animal, and it is probable that the N.A.A.F.I. is not so well appreciated as it might be. Moreover, there is always a lingering apprehension in the soldier's mind—too well justified by past history—that his employer, the State, is always trying to get the better of him. Hence there remains the tendency, in case of any little failure or disappointment (for the institution which never was guilty of failure has never yet existed in this world), to blame some vague person or persons who are supposed to be at their old nefarious work. . . . They must realize that the N.A.A.F.I. is not a force imposed upon them by external authority. It is their own Institute, built up by themselves for their own benefit."

P.H.K.

"POLITICAL MEMOIRS, 1914-1917."

Pages from my Diary. By PRINCE NICHOLAS OF GREECE. (Hutchinson & Co., 1928. Price 24s.)

It was generally believed during the War, and after, that the late King Constantine—influenced by his German Consort—was mainly responsible for the refusal of Greece to join the Allies.

This volume has been written by a brother of the King to show not only that there was no real ground for this belief, but, moreover, that the King was cruelly maligned and wilfully misunderstood by M. Venizelos. This well-known statesman was the leader of the Liberal party in Greece, and, up to March, 1915, Prime Minister. Prince Nicholas endeavours to show how it came about that M. Venizelos and the newspapers he inspired were responsible for misleading the world as to the true facts.

King Constantine was a soldier in more than name. He had won his spurs in two victorious campaigns, and if Greece had joined the Allies in 1915, he would have led her armies as Commander-in-Chief. He was

extremely popular with the people: he understood them, and they trusted him. He realized that the Greeks were not only tired of war, but were totally unprepared for another struggle; and it was for these reasons that he stood firm from the first for Greece's neutrality in the general conflagration in Europe.

He and his General Staff were always suspicious of their former adversary, Bulgaria, and were determined to safeguard the conquests they had made, at all costs. It was because they lived in fear of a war of *revanche* that a defensive alliance had been entered into by Greece with Serbia, under the terms of which each was bound to go to the assistance of the other if attacked by their former enemies.

Much has been written and said about the failure of Greece to go to the assistance of Serbia when the latter was threatened by the combined forces of the Central Powers. Prince Nicholas shows that M. Venizelos must share with the King the responsibility for the decision. They held that Serbia, attacked by Austria and Germany, as well as by Bulgaria, could not possibly be in a position to fulfil her promise to send the 150,000 men that Greece had stipulated, to the aid of Greece if the latter were attacked, and that for self-preservation Greece must first safeguard herself against direct attack by Bulgaria, backed as she would be by Germans, Austrians, and probably also Turks. King Constantine and M. Venizelos were both determined that Greece should not be deprived of the territory she had won. M. Venizelos, perhaps, held a longer view. He believed that with Entente assistance Greece would be able not only to hold on to what she had won, but in the event of an Entente victory, might gain territory elsewhere. Like all good Greeks, he, no doubt, had dreams of re-establishing the Byzantine Empire. Unfortunately for Greece, the Allies were determined that this should never be, and they had already clinched the matter by promising Constantinople to Russia.

When the Allies began to realize the potentialities of the coastline of Greece for German and Austrian submarine bases, they redoubled their efforts to persuade Bulgaria to join them. They were apparently convinced that the fears of Bulgarian aggression were groundless, and they refused to accept the Greek point of view. Moreover, not content with thwarting the aspirations of Greece, they grievously injured her *amour propre* by offering to restore to Bulgaria part of the territory which she had lost to Greece, as a bribe to King Ferdinand to join them. This the Greek nation could not stomach, and the King and M. Venizelos correctly interpreted the sentiments of the whole nation in protesting against this insult. The King became only more determined that nothing but Bulgarian aggression would induce him to abandon neutrality. M. Venizelos an optimist always, and a believer in the ultimate success of the Allies—cherished the idea that if Greece could not get help from Serbia she might get it from the Allies. He persuaded the King to agree with him under certain stipulations, one of which was that Allied assistance must be in the form of "Metropolitan Troops, not Colonials." Presumably the King would not be content with anything but regular white troops, whether French or British: he had seen what had happened in Gallipoli, with raw, half-trained levies.

M. Venizelos, not content with the half-hearted acquiescence of the King, then took upon himself to invite the Allies to Salonika. This fact, Prince Nicholas states, only became known to the world after the War. He goes on to discuss the extraordinary situation after the arrival of the Allied contingents. Foreign troops in a neutral country, with the representatives of the enemies of the Allies still installed at Athens! From this moment, M. Venizelos was definitely, if not openly, at loggerheads with the King; and the story of intrigues, to which such a situation was bound to give rise, is a sorry one. Prince Nicholas has no use for the diplomatic representatives of the Allies at Athens. He charges them, and particularly their creation—the Allied Intelligence Corps—with concocting all kinds of false stories of Greek delinquencies which were widely circulated by the Venizelist Press at their, and M. Venizelos', instance. He describes the landing of the French Marines at the Piraeus, and attributes the conception of that intervention to M. Venizelos, who must, he says, have been well aware of the inevitable consequences. M. Venizelos was obsessed, he says, by the desire to force the nation into the War at any price, even if it involved the removal of the reigning sovereign, if not the overthrow of the dynasty. As to the subsequent action of the Allied diplomats, he is very outspoken, and although it is evident that he considers that all were involved, he attributes most of the trouble to the French Government, and to the politicians, military, naval and civil, who were its representatives in Greece.

In a chapter on General Sarrail at Salonika, he describes the French General as—"though a soldier, he was a militant republican and "politician as well: in the course of his command in the Near East "these 'credentials' were often combined." He regards him as having been the prime cause of the Greek refusal to join the Allies, when shortly after his arrival he ordered the demolition of the railway bridge at Demvir Hissar on the Struma river, thereby cutting off the Greek forces in Eastern Macedonia from their base at Salonika, and completely upsetting the Greek strategic concentration and cutting the Greek forces in two—in other words, completely paralysing them. . Prince Nicholas also describes the circumstances that led up to the inexplicable surrender of two Greek divisions at Cavalla to the Germans, and their removal as prisoners of war to Germany. He records that the King and the Government were entirely unaware of what was happening there, and only heard of the surrender after the first Greek detachment had arrived in Germany. After describing the revolution engineered by M. Venizelos, the book ends with the exile of King Constantine and the accession of his younger brother. Not a single mention occurs in the book of the British Commander-in-Chief, or of the troops under his command.

The book should be read, for it gives us a very different view of what happened in Greece to what we are accustomed. The reader who has also read the author's companion volume, *My Fifty Years*, in which the Asia Minor campaign is described, will gain a very good idea of the Salonika "venture," from the Greek point of view. But it will not increase his admiration for Allied diplomacy in the Great War.

H. B.-W.

RAILWAYS.

By W. V. WOOD, Controller, and SIR JOSIAH STAMP, President, L.M. & S. Railway.

(Published by Thornton Butterworth. Price 2s.)

This perhaps is the first book to be published by any English railway dealing with its business in a manner not suitable for the juvenile reader. But it is difficult to place its exact intentions. In the first chapter, we read: "The first fruits of division of labour were functional, the second into which we now enter are spatial or localized." Whatever this means, it is rather unsuitable for either the general public or the railway student. In another chapter, we read: "The admission of steam into a cylinder forces a piston to the other end, and this force . . . causes the wheels to revolve." These remarks seem more suited to the nursery rather than to form a basis for the "new thinking" which the book is intended to promote.

A few lines further on, we are told that the power of a locomotive depends on various details of its design. Details of design are now more or less stereotyped, or should be so, and for the informed reader, the important feature in any locomotive is the amount of coal it can burn in, say, half an hour.

A chapter is devoted to the elementary history of transport.

A chapter on statistics devotes more attention to their abuse than their use. The fact is statistics compiled all over the world have already brought about the solution of the major problems of railway working, and it is rather late in the day for English railways to begin compiling them. It would be sufficient to make use of the experience gained elsewhere, and apply the general principles of railway economics which this little book briefly and accurately describes.

The advantage of high train load and large wagons is correctly described, but one looks in vain for a reasonable explanation for the failure of English railways to increase wagon load and train load. We are told that dealers in household coal like to get supplies in five-ton daily lots. An inadequate excuse for an apparent loss of millions in working expenditure. We read that another reason is to be found in the smallness of the average goods consignment. This again is unconvincing as 80 per cent. of the traffic is in minerals and metals, which are consigned in full wagon loads.

The loss on working the freight traffic can be readily estimated. The average wagon load is 3 tons, and each wagon weighs 6 tons empty. The small load is due to private wagon empty haulage, and small capacity for loading light goods. In well-designed stock the average load may be 10 tons for 8 tons weight of wagon for a similar class of traffic. By simple proportion, we find that for every 100 tons of freight carried, 80 tons of dead weight is good practice, but English railways carry 200 tons of dead weight. The balance, 120 tons, is being dragged about the railways wearing out the rails, using up labour, and burning coal.

Probably £10,000,000 is lost on this in working expenses. The shunting mileage is 80 per cent. of the train mileage, an appalling figure, and leaving room for an economy of millions.

The book gives a fact not generally known, that the rails in common use are 95 lb. per yard. Such rails are suitable for 20-ton axle load on the wagons and 25 tons in the engines. The majority of the wagons have only 8-ton axle loads. This means that much of the capital outlay on the rails is wasted.

The real reason why English railways do not increase their wagon and train load is that until they increase the size of the loading gauge it is impossible to increase the size of the engines. They are unable to face the capital outlay to do this. It would be impossible to raise the money, and they have no reserves. We read that coal consumption is carefully watched, each driver and stoker's record is watched. The drivers and stokers are the best in the world, and watching them seems superfluous so long as every goods train contains 180 tons of unnecessary dead weight, out of a total weight of 400 tons. Actually, it must be worse than this. A reduction of dead load would reduce the number of trains, engines and brake vans in use, and the total waste load is probably 240 tons for every 120 tons of paying load. This is the unnecessary dead load, excluding the unavoidable dead weight of trucks and engines amounting to 175 tons.

On page 89, it is stated: "In their general design, wagons have altered little in the last 100 years." Comment would be superfluous.

Enlargement of the loading gauge will equally affect the passenger traffic, and make it possible to cope with London suburban traffic, and gain the full value from electrification.

An interesting chapter on Government control leaves the impression that Government acquisition of the railways would come as a relief to a hard-pressed railway administration.

The railways have been so much interfered with by the Government, that they might well demand that the Government should take control. Certainly the shareholders have every reason for demanding such action, their interests having often been lost sight of.

Private ownership in industry combined with individual effort may always be preferred to State ownership, but in large corporations individual control is lost, and the history of our railways, which were amalgamations of a number of small lines made 60 years ago, shows only too clearly that amalgamation, although it has obvious advantages, has also many drawbacks.

The remedy for regaining effective individual control of large amalgamations is the deferred share in the hands of a few individuals. But the stocks of our railways are too widely dispersed, and could never be collected into a holding company by private effort. The socialist dream of State control of all large corporations may, in the not distant future, be brought about by the impossibility of otherwise controlling them. Certainly our railways are ripe for it. State acquisition would enable the State to control all the railways by means of a small board of two or three railwaymen. Their first act would be to repeal the existing railway laws, and enact a simple code in their place.

They could then find the money, and proceed to modernize the railways. Many of the unemployed may be absorbed in this work for five years. A few small companies would be formed to work the traffic on lease.

On page 226, it is stated that "the low return in the industry is due to the fact that a greater part of the capital was issued when money was cheap—74 per cent. receives only about 4 per cent." This would convey to an uninformed reader the idea that the low net earnings of our railways are due to the cheap credit which they alone enjoy. A decidedly new point of view.

There is much said about the hours of labour, and it must be admitted that railway labour has done very well out of the War. The book makes the statement that the rise in the cost of labour is 150 per cent. or, allowing for rise in prices, 50 per cent. on pre-War expenditure. One can only admire the railwaymen for getting the best of it, and ask the administration why they have been bested.

That the technical labour know their job, no one can doubt. One may kill a salmon on the Usk at 4 p.m., and have it delivered in a remote village, 100 miles away, through three junctions, by 10 a.m. the following day, for the sum of 2s. 6d. No railway in the world can beat this; but what one would like to know is why, with this wonderful labour staff, and with 70 per cent. of their capital in 4 per cent. irredeemable debentures, and high rates ruling, the L.M. & S. stock has fallen from £137 to £50 per cent. since 1910, while at the same time railways with fewer advantages all over the world are more prosperous than ever before? Motor competition has very little to do with it. Motors make more new railway traffic than they take away.

The irredeemable debenture is not the least of the mistakes of the early railway legislation. If the railways had been obliged to renew their debentures every few years, it would have been much better for their health.

L. E. HOPKINS, Lt.-Col.

LUFTFLOTTEN (AIR-FLEETS).

Published by the *M. und T. Mitteilungen*, Stubenring 1, Vienna I. 380 pages, 53 illustrations. Price, 5s. paper covers, 6s. half-linen.

This, the latest production of the *M. und T. Mitteilungen*, consists of a collection of thirty-three articles written by experts, all dealing with some aspect of aerial warfare. *The Air-fleet Politics of the Great Powers* is followed by *Organizations and Strengths of the Armed Air-fleets of the World*, in which a prominent German writer on aerial matters accords to the British air forces a political significance greater than, and a fighting value nearly equal to, that of France. The editor of the *Aeroplane* discusses *The Military Significance of Civil Aviation*, and leads us to the following conclusions: as regards personnel, practically negligible; as regards equipment, practically negligible; as regards ground organization, vital.

Aerial Warfare Questions is based upon an article by Col. J. F. C. Fuller. *What are the present performances of aircraft ?* is then answered, as also another question, this time frankly controversial, *Fighter or Cruiser ?* in which we are given the arguments of both parties. After *Air-fighting Formations* comes *Teachings of Up-to-date Manœuvres*, in which a Hungarian officer denies the contention by the English Press. that the defencelessness of London was clearly shown by the manœuvres of July, 1927. The next article, *The Disarmament of Air-fleets*, by Col. Streccius, of the German War Office, and member of the permanent consultative Commission for Aerial questions of the League of Nations, may occasion some surprise in its present company, as a Daniel among the lions. Granting that air-disarmament is to be aimed at, the author rejects as impossible the abolition of all military aviation, and as insufficient, failing good-will, the limitation of numbers or horse-power. If the nations will do nothing of themselves, and it is left to the League of Nations to take the first step, then the demand must be ABOLISH ALL BOMBING !

After this we get back to business with *The Airship as a Weapon in Land and Sea Warfare, Past and Future.* Every weapon has its day until a more effective one arrives. The aeroplane took the airship's place in land warfare, because it can fulfil the same tasks better and with less danger to itself. " Never again will an airship take part in land warfare." It is quite another story when we turn to the sea. There the airship's important duties remain, distant reconnaissance, escort-duty, patrolling, mine and submarine hunting. The activity of Great Britain, the U.S.A. and Italy shows them to be alive to this fact : only France and Japan are behind. Important for further development are the two great technical advances since the War, helium-filling and the anchor-mast.

Among the photographs are the twin airship sheds on a turn-table near Cuxhaven, and the *Shenandoah* riding to the anchor-mast on board the airship mothership *Patoka.*

The Captive Balloon and the *Use of Kites for Military Purposes* are dealt with shortly. Under *Aircraft Petrol Supply in War*, estimates show that a Great Power at war in the next few years will have to import 2½ million tons of oil a year in order to get the petrol it needs for military aeroplanes alone, or more than a quarter of the tonnage of the world's oil ships. Consequently, great stores of oil must be collected in peace. Consequently, the first task in war will be to destroy the enemy's oil-reservoirs. In order to ensure the petrol to the aeroplanes it will be necessary to provide engines running on heavy oil for tanks and all motor-transport.

It is too early to take into account that installations are already working in which coal is liquified, but the development of such establishments and the perfection of their methods will have as great an effect on this question as it will generally on the world's economics.

The Influence of the Air-arm on Infantry Tactics and *The Relations Between Infantry and Aircraft* are complementary. They coincide only in considering the influence of the air as increasing. In *Gas Warfare and Smoke-formation from Aircraft*, the author considers gas pre-eminently

the best means of waging war against human beings, and chooses the mustard-gas bomb, arranged to work 200 to 300 metres above the earth, so that the contents fall in a dust-like rain. Compared with artillery, the gas-bombing aeroplane has only one possible firing-position, viz., low down and just above the target. Opinions differ as to how much chance the aeroplane has of reaching this spot. Be that as it may, "indirect" bombardment by night, using wireless position-finding will be all in the aeroplane's favour, as will also the less noisy heavy-oil engine.

As regards the formation of smoke from the air, this is of the most urgent necessity in order to alter the state of affairs brought about in the Great War, where the continual increase of weapon-effect (the first element of tactics) made movement (the second element of tactics) almost impossible. Tactics failed in position-warfare, because the balance between weapon-effect and movement was lost.

The tank was an attempt to restore this balance, and the subsequent efforts, especially in the British army, towards complete mechanization, are a continuation of the policy started by the tank.

There are many difficulties in this way, among which may be mentioned that the tank is essentially a weapon of attack, and of attack alone, while in battle movements of attack and defence must alternate and interweave.

A new way out of the deadlock of tactics is offered by artificial smoke, which is just as promising a solution as the tank, far cheaper, and can be used always and everywhere. The best agent is the low-flying aeroplane, which, according to American trials, can produce in less than a minute a thick curtain of smoke a mile long and 500 feet high.

It is smoke produced thus, and also by the infantry by means of smoke-grenades, and by the artillery by means of smoke-shell, which will reduce the preponderance of weapon-effect in tactics by restoring movement to the battlefield, and thus raising man's value in comparison with the machine.

The next three articles are historical: *Austria's Share in the Conquest of the Air*, *Austria's Military Airships* and *The Austro-Hungarian Air-troops in the Great War*. They are followed by *Principles of the Statical Calculation of Aircraft*, *Aero-Mechanical Testing*, giving some account of towing trials and the blast method for models, and *Recent Aeroplane Types*, which describe the two latest sailing aeroplanes. The author says the ultimate object of all these sailing trials is to improve the flying qualities of the engined aeroplane.

The story of *The Helicopter* is then told, and the author includes an account of a later attempt to solve the same problems, the Autogyro, which is no helicopter, but an aeroplane with rotating wings.

Automatic Flight gives diagrams of instruments and connections by means of which Drexler claims that, after twenty years of experimenting, he has succeeded in making an aeroplane fly itself. The apparatus he has made can be fitted into any aeroplane with four screws and the inventor foresees a time when every aeroplane will be so fitted.

Sailing Flight tells what has been achieved in the Rhön, near Darmstadt, and at Rossitten among the dunes in East Prussia. The records

for engineless flight are: longest time in the air, 14 hours; greatest height, 650 metres; greatest distance, 62 kilometres. "Sailing flight is in the best sense of the word an art, where the will of the airman, led by instinct, has to do duty for an engine." The author hopes that through generations of practice the youth of the future will possess the necessary instinct!

In dealing with *Aero-photography and Aero-photogrammetry*, the aim has been to show the degree of perfection achieved by Hugershoff-Heyde's Aerocartograph and the Zeiss-Jena Stereoplanigraph. *Aeroplane World Records* and *Aircraft Navigation Instruments* are also dealt with, and five articles on *Air Defence* bring the symposium to a close.

There follows twenty-four pages of reviews of, and notes on, the air literature of the leading countries, including a review of Gen. Niessel's *La maîtrise de l'air*, and Notes on the British Air Estimates, 1927–28, air establishments and policy. A six-page list, with notes, of the air periodicals of the world completes this air encyclopædia and leaves one full of admiration at one more example of the thoroughness with which the *M. und T. Mitteilungen* fulfils its policy of keeping Austrian officers up-to-date in those fields in which their own efforts are at a standstill, owing to restrictions imposed by the Treaty of Versailles.

F.A.I.

THE MURMANSK VENTURE.

By Maj.-Gen. Sir Charles Maynard, K.C.B., C.M.G., D.S.O.

(Hodder & Stoughton, Ltd. 1928. Price 20s.)

Why did we intervene in Russia in the spring of 1918?

It was to answer this question and endeavour to dissipate the general misconception existing on the subject in the public mind, that the author has given us this book. There were obvious political reasons why he did not put pen to paper much earlier, and there was a danger of incriminating further in the eyes of Moscow those Russians still living who, having thrown in their lot with the Allies, had declined to accept the opportunity offered them of seeking an asylum outside their own country.

General Maynard reminds us of the military and political situation at the opening of 1918, and he sums up the reasons for our intervention, as follows: "(*a*) Many more German divisions would have been with-" drawn from Russia and employed against the Allies in France—possibly " with decisive results. (*b*) Germany, being free to draw on the immense " resources of Russia and Siberia, would have been enabled to establish " her national industries once again on a prosperous footing, and to " supply the needs of her civil population. The effect of our maritime " blockade would thus be annulled. (*c*) North Russia ports would have " been converted into enemy naval bases, submarines operating from " which would have circumvented our North Sea minefields, and found " our Atlantic commerce open to their attack. This, too, when the " safe transport of America's armies was of all importance. (*d*) The " chance would be lost of employing to any useful purpose either the

" army of Japan or the equivalent of several divisions of Czecho-Slovak " troops of high fighting values, and full of enthusiasm for the Allied cause. " (*e*) The anti-German movement at that time beginning to gain a hold " in Russia would, if unsupported by the Allies, be quite unlikely to " achieve any tangible result."

General Maynard claims that our intervention was more than justified as a measure of sound strategy, and that the aim of the North Russia " detachment " was fulfilled with a measure of success out of all proportion to the slender means employed.

After reading the volume, it must be admitted that, in this case, if not in some others, the " eccentric " venture, entailing as it did the diversion of strength from the main theatre of operations, was in 1918 fully justified. If it did not achieve its secondary object of helping to rescue Russia from the Bolshevicks, the failure cannot be attributed to the British and Allied troops who served under British leaders in Murmansk and at Archangel.

It is interesting to learn from General Maynard that, as in the case of the Salonika " venture," British co-operation was probably secured by the fact that the British Admiralty laid great stress on the denial of submarine bases to the enemy. That this was so is evident by the veto placed on General Maynard's suggestion that the strength of his force did not allow of retaining a garrison at Petchenga, an ice-free port sixty miles N.W. of the Murmansk (Kola) inlet, and by the fact of the immediate dispatch to him of 5,000 reinforcements, to ensure the success of his advance to the shores of Lake Onega without prejudicing the safety of Petchenga.

The book has done a real service in giving us one more example of the inter-dependence of naval and military operations, and provides another argument for taking steps to ensure the very closest co-operation between the Naval and Military General Staffs in any future war in which the British Empire may be involved. It is true that there appears to have been good co-operation in this case, but there is reason to think that that result was only achieved by the personality of the occupants of the chairs at the War Office and Admiralty who were in charge of the White Sea operations. Our Imperial organization must, in future, be such that there can be no question of the interests of one branch being subordinated to those of the other. It is to be hoped that the creation of the Imperial Defence College will go far in educating those who are to be responsible for the defence of the Empire of the truth of this maxim, and the necessity of creating an organization which will effectively prevent a strong man at the head of any one branch of the Government from taking the bit in his teeth. The Admiralty was allowed far too free a hand in Gallipoli; the Foreign Office in Greece; the Minister responsible for man-power in France in the winter of 1917–18.

General Maynard does not claim to have written anything in the nature of a detailed report, nor to have produced a strategical or tactical study of the operations, but he has given us a very interesting account of a minor campaign which was in many ways unique, and was carried out by one of the most motley forces ever brought together for the

purpose of military operations, under climatic conditions hardly ever experienced by British troops and in a political atmosphere which few at home can have realized.

It is to be regretted that the volume is not provided with a proper index: the summary of contents is hardly sufficient. A general map of Northern Russia and Scandinavia would also have helped the reader.

H.B.-W.

MEMOIRS AND ADDRESSES OF TWO DECADES.

By J. A. L. WADDELL. Edited by FRANK W. SKINNER.

(Published by the Mack Printing Company.)

This book is a collection of those of Dr. Waddell's numerous papers that had not yet been published in full in book form, and of speeches delivered to various bodies on matters relating to the engineering profession.

Dr. Waddell, in his long and busy engineering life, has seen, and taken a leading part in, the development of modern bridge engineering from its smallest beginnings, and as this is most probably the last of his works, it will be of interest to review, very briefly, his technical life before dealing with the book itself.

He was born at Port Hope, Ontario, in 1854, and received his technical education at the Rensselaer Polytechnic Institute, New York.

In 1871, he entered the service of the Canadian Pacific Railway and after seven years of varied engineering experience, he returned to the Rensselaer Institute as lecturer in Geodesy, Geometry and Mechanics. From 1882 to 1886, he occupied the chair of Civil Engineering at the Imperial University at Tokyo; after which he returned to America and practised as a Consulting Engineer.

Dr. Waddell was fortunate in that his engineering life was spent chiefly in a young and wealthy but undeveloped country, affording such great scope for major engineering works. Some idea of his vast experience may be gathered from the statement that, not counting such works as the construction of two lighthouses, harbour and dock works, railway works and other activities which would be considered a sufficiency for the average engineer, he has been responsible for the design and erection of upwards of a thousand bridges of every conceivable type, most of which may be classed as major works!

During the last forty years, covering the busiest part of Dr. Waddell's professional experience, he has found time to write six technical books (besides two written in Japan), including *De Pontibus* (an encyclopædic handbook of modern bridge construction), two volumes of *Bridge Engineering*, and *Economics of Bridge Work*. Besides those, he has written upwards of a hundred technical papers, addresses, monographs on important engineering, mathematical, constructional, ethical, and educational topics that have been published in the principal foreign languages.

To-day, Dr. Waddell is Consulting Bridge Engineer of the Port of New York Authority on the design and construction of two bridges, to

cost some £3,300,000, that will connect Staten Island with the State of New Jersey, on which the construction is rapidly drawing to a close. He has been consulted on several other important bridge constructions now pending, including enormous spans for San Francisco Harbour, as well as the contemplated single span across the Narrows of New York Harbour, which he has estimated might be constructed at a cost of about £20,000,000 for a 5,000-foot main span with 130-foot roadway.

It will be realized that Dr. Waddell's editor, Mr. F. W. Skinner, has some excuse for his (to English ears) rather effusive style when discussing American Engineers in general and Dr. Waddell in particular; but one feels that such a record might have been left to speak for itself. Not that Mr. Skinner has any reason to fear that any slight over-accentuation of his author's undoubted merits would be likely to cause embarrassment to his subject; to read a few of the articles in Groups I to IV of the book is to realize this.

Mr. Arnold Bennett, in discussing another combination of editor and author, very aptly describes the impression created by this book. "M. Benjamin is inclined to sentimentalize the prodigiosity of Balzac's career. Balzac had not only grandeur; he was grandiose. M. Benjamin insists too much on both characteristics. He paints the lily."

The book is divided into eleven groups, the first four groups being devoted to papers and addresses on matters relating to the ethical and educational training of the engineer. This portion could well have been condensed considerably. It contains some good advice in a very great number of words. The non-technical portions of the tenth group also —"Matters Chinese"— suffer from the same defects of style. These five groups are not so much written as "orated" in windy language, sprinkled with tags of foreign tongues, and *clichés*.

The meat of the book is contained in Groups V, VI, VII, VIII and IX, which are devoted to technical matters.

The style of these technical papers is much clearer and more to the point than that of the articles in the five groups previously noticed.

Much of the matter, however, has already appeared in *Bridge Engineering* or *Economics of Bridge Work*, though in a condensed form.

The articles on the use for bridgework of alloy steels with elastic limits of 60,000 lb. and upwards, are interesting and instructive.

In 1903, Dr. Waddell was retained by the International Nickel Company of New York City, which company then controlled three-quarters of the world's total output of nickel, to make an extensive investigation into the possibilities of nickel steel for bridge-building. His experiments included all standard and many special practical tests, and occupied over three years. The result of his investigation has been the use of nickel steel for several long-span bridges, including the Manhattan Bridge, New York, the Free Bridge, St. Louis, the New Quebec Bridge, and several other important structures.

It is interesting to know that these investigations into the use of nickel steel were carried on until early in 1913, when the cost of nickel rose to an uneconomic price for large scale work, due to heavy purchases by Germany for the manufacture of War material.

Another matter which might have had some effect on the conduct of

the War was the proposal, in 1907, to link up the Russian and United States railway systems by tunnel under the Bering Strait. A company, called the Trans Alaska-Siberian Railway Company, of which Dr. Waddell was Chief Engineer, was formed, and the preliminary work up to commencement of actual construction was carried out; but the project was abandoned because of international complications.

Articles of interest to the railway engineer are those on the creeping of rails, and the respective merits of vertical and inclined rails. The articles of most general interest, however, and those which constitute the principal value of the book, are those on the "Functions and Work of a Resident Engineer," "Bridge Economics for Foreign Lands," and "The Suitability of Bridge Types for Different Crossings."

The first of these articles gives some very useful hints on the conduct of bridging work and of any large engineering job; it would be a very valuable paper to have at hand when undertaking such works.

The other two papers mentioned properly go together; combined, they form a very comprehensive and lucid appreciation of the many factors which should be taken into account when the type of bridge best suited to any crossing or geographical situation is to be decided upon.

Without occupying too much space, more particular mention of these papers cannot be given here—except what follows on the Hooghly Bridge project, which is mentioned in the one last named—but one feels, after many weary hours of wading through so much talk that says so little, and repeats it so often, that here at last is matter which one would like to have by one always.

The Hooghly Bridge project is discussed in several places in the book, but chiefly in the paper mentioned and in a reprinted letter to the editor of *Indian Engineering*.

Dr. Waddell roundly condemns the methods of the Committee in charge of the preliminary work, their lack of engineering knowledge, and the selection of a floating bridge, which, it must be admitted, is tantamount to a confession of failure.

After making allowance for a possible bias in Dr. Waddell's feelings after the rejection of his proposal for a cantilever bridge with a central vertical lift span, it is impossible to read his remarks without an uncomfortable feeling that his summing-up—"A more badly handled bridge project than this would be difficult to conceive"—is only too true.

To sum up. The book cannot be said to add anything to Dr. Waddell's reputation. There is a great deal of valuable matter contained in it—Dr. Waddell knows the theory, practice and business of bridge engineering works better probably than anyone else—but there is too much chaff with the grain. A book one-third the size would have been extremely valuable, because it could have been published at a price and of a size which would have enabled individuals to buy it and use it. As it is, the good there is in it will be lost, because the book will take its proper place amongst other neglected mines of valuable information, on those forgotten shelves of technical libraries, where, deep in dust, lie the bound volumes of the "proceedings" of learned societies.

A.M.

(1) SURVEY OF INDIA, PROFESSIONAL PAPER No. 20 (RECONNAISSANCE SURVEY FROM AIRCRAFT).

By LT.-COL. G. A. BEAZELEY, D.S.O., R.E.

(Price 2s. 6d.)

(2) PROFESSIONAL PAPER No. 21 (IRRIGATION AND SETTLEMENT SURVEYS, 1926.)

By MAJOR J. D. CAMPBELL, D.S.O., R.E.

(Price 2s. 6d.)

(3) THE TIDES. Part V of the HANDBOOK OF PROFESSIONAL INSTRUCTIONS (3rd Ed.) OF THE GEODETIC BRANCH.

By MAJOR C. M. THOMPSON, I.A.

(Price 3s. 6d.)

(Published by order of Colonel-Commandant E. A. Tandy, R.E., Surveyor General of India.)

(1) This is a very thorough and well worked out exposition of a method of visual sketching of the ground from an aeroplane. Colonel Beazeley had much experience of this method of map sketching during and after the War, and we fancy got all there was to be had out of it.

We can quite imagine it being useful in certain circumstances in war, but they would be limited. This kind of sketching from an aeroplane, travelling at 75 to 100 miles an hour, to be of any value would require a great deal of training and constant practice. But even granted all this, it is not easy to see how it could compete in any way with aerial photography using modern cameras and apparatus for rapid development and printing, unless perhaps in a climate which only presented rare opportunities for photography.

Another disadvantage, for use in war, is the comparatively low altitude, of about 6,000 feet, at which the sketching must be done. Also, we gather, the sketcher has to work in the full blast of the slip stream while travelling at, say, 90 miles an hour.

Though we could hardly recommend this method for general use, we are filled with admiration of the way Colonel Beazeley has worked out all the details connected with map sketching from the air.

(2) In India, some 25,000,000 acres are irrigated by canals. In a country of such great irrigation schemes, where large numbers of people have to be allotted land often in desert, or semi-desert, areas which the advent of water will convert into some of the most fertile tracts in the world, it has become necessary to lay out accurately and measure the land taken up by settlers.

It is also necessary to have an accurate system of levels required by the engineers in designing the system of canals and channels, so that the largest possible area may come under irrigation and may be available for settlers in the new colonies.

This report places on record new methods, only, which have been used for these purposes and which fall outside the normal work of the Survey of India, as everything pertaining to the latter has already been fully described in other professional publications.

The process of marking out areas to be irrigated is known as rectangulation, which is defined as the dividing up of any portion of land surface into rectangles of fixed size, by accurate methods, and demarcating them with permanent marks. This is actually done by determining on the ground accurately, by triangulation or traversing, the corners of the largest rectangle which can subsequently be broken down by what we may call alignment and direct measurement, without further resort to triangulation or traversing. The large rectangles must, of course, be multiples of the smallest subdivision aimed at. The size of these primary rectangles depends on the nature of the ground, the length of the sides must not be greater than it is possible to see from one end a signal placed at the other, so as to admit of easy subdivision. In ordinary country, rectangles of about 2½ miles by 1½ miles have been found suitable.

The next operation after the area has been subdivided, which was usually carried by the Survey of India to 25 acres, was to determine the levels of the corners of these small rectangles and at points along their sides. From these, the whole area is contoured to 1-foot intervals and the resulting plans are used by the irrigation engineers for the design of the project.

Rectangulation carried out in a scientific and systematic manner, as now practised, has the great advantage that it comprises in a single operation the requirements of the Irrigation and Revenue Departments. It gives an accurately contoured representation of the form of the ground and it affords a means of allotting areas to colonists in a most exact manner. To be thoroughly effective, it is necessary to have the closest co-operation of these departments with the Survey of India.

The report under review contains a detailed account of the various operations involved, with numerous plates illustrating each step. It is, we believe, the most complete account which has yet appeared on the subject of Irrigation Surveys, and should be studied by all engineers who have to deal with conditions similar to those which prevail in India.

(3) When the tide-predicting machine, belonging to the Government of India, was transferred from the National Physical Laboratory, Teddington, to the Geodetic Branch office at Dehra Dun and not only the Harmonic analysis of tidal observations but also the actual preparation and printing of the tide-tables was undertaken by the Survey of India, it became necessary to revise the professional instruction on the subject. This volume is the result.

A short historical review is given of the various tidal theories, followed by a detailed account of the method employed by the Survey of India in predicting the tides, with a worked-out example to fully illustrate the process.

There is a chapter on tidal observations and a description of the tide-gauge used for the purpose by the Survey of India, at the various ports where observations are carried on.

The tide-predicting machine, and its working, is also described in detail with illustrations.

Several improvements have been introduced by Dr. J. de Graaff Hunter since the machine was set up at Dehra Dun. The principal one appears to be the chronograph attachment by which the times of high and low water can be more accurately read, as the exact times are directly registered and have not to be estimated.

Anyone wishing to study the methods adopted by the Survey of India in the preparation of the tide-tables for Indian waters is recommended to read this work.

H.L.C.

THE PRINCIPLES OF UNDERDRAINAGE.

By REGINALD DAVID WALKER, M.C., A.R.C.SC., D.I.C., A.M.I.C.E.

(Chapman and Hall. Price 15s.)

Starting with a series of definitions of technical terms, the author proceeds to explore the sources and disposition of underground water, in such a way as to lead up logically to a statement of the objects and theory of underdrainage, and so to a general explanation of the methods of surveying and siting the various portions of the systems.

From the table of depths and frequencies of underdrains, it appears that he advises a somewhat wider spacing of the laterals than is usual in W.D. practice; the differentiation, however, between the systems to be adopted in localities of shallow and deep water table level is extremely sound, and follows logically upon the theories previously developed.

It is not quite clear why the anti-malarial theory of drainage is considered of sufficient general importance to warrant the devotion thereto of a separate chapter. It is, however, fully and logically treated, while the study of the economic aspect, although necessarily somewhat parochial, is of interest in demonstrating the wide range of circumstances in which superficial oiling is financially preferable to underdrainage.

It is unfortunate that the page headings throughout this chapter should have been so misleadingly abbreviated.

The following chapters, devoted to a detailed consideration of the underdrainage of ravines, flat lands, cuttings and embankments are full of interest, although it is a matter for regret that the author has focussed his attention so exclusively on conditions prevailing in the F.M.S. We infer from his preface that he desires his book to be of value to engineers generally, yet the inherent particularization of its application is perhaps most typically illustrated by the proportioning of the entries in Tables 3 and 4.

Though a similar criticism must be levelled at the economic data which are of purely local value, the general specification is good, and might well be used as a model in any quarter of the globe. As might be expected from the title of the book, the section dealing with open drains is less fully detailed, the use of Table 25 being hardly demonstrated at all; while the appendices, although serving to display the versatility of the author's knowledge, might with a small amplification of the main text have been quite reasonably omitted.

Judged from the aspect of a reference book, the index is adequate and the style and illustrations are admirable; one can only hope, therefore,

that in his next edition, Mr. Walker will endeavour to enlarge the scope of his work and render it as valuable generally as it undoubtedly is now in the F.M.S.

A.D.C.

UNDERGROUND CABLE SYSTEMS.

By G. W. STUBBINGS.

(Chapman & Hall. Price 15s. net.)

The introductory Chapter I gives a very brief history of the subject.

Chapter II, on the "Physical Constants of Cables," is concise and to the point. It is unfortunate that the author uses "capacitance" and "capacity" to mean the same thing. This occurs throughout the book.

Chapter III, on "Cable Construction and Manufacture," contains some useful information. The remark, on page 20, that multicore cables often show economy over single core cables is quite true, but it should be emphasized that it is not always so, as a much larger current density is permissible in single core cables than in multicore.

No reference is made to "locked coil" armour, which, though somewhat more expensive, combines the advantages of wire and tape armour.

Chapters IV and V, on "Cable Laying and Jointing," IX and X on "Faults and Their Localization," and XII on "Plans and Records," are all well written and show the author's intimate acquaintance with the subject.

Chapters VI, VII and VIII deal with the theory of networks. The methods adopted to get the voltage drop in a distributor, on pages 67 to 69, appear unnecessarily complicated, but this may be a matter of opinion.

No reference is made to the voltage drop in the neutral of a 4-wire 3-phase system. The mains engineer who neglects this may find himself in difficulties.

Chapter XI is an excellent *précis* of our present knowledge of E.H.P. Cables.

Chapter XII deals with "Automatic Protective Systems," in a clear manner, although the value of the first few pages would have been much enhanced by the addition of a few sketches.

Chapter XIII, on the "Electrolytic Corrosion of Cable Sheaths," explains the matter clearly, from the supply company's point of view, but it is not brought out that it was the water and gas services which forced attention to the matter in the first place.

Chapter XV gives a brief treatment of the most common tests, and in conclusion are given three useful Appendices—I, "British Standard Test Voltages"; II, "Glossary of Terms and Definitions"; and III, "Current Carrying Capacity of Conductors Under Various Conditions."

The book is good value both to the student and the engineer, and the Bibliography at the end of each Chapter will be of great assistance to the reader who desires to pursue the subject.

The following slips and misprints are noted:

Page 12, C_s for C_e in three places; l is shown as a numerator, instead of as a denominator, in the third formula on page 13; page 67, line 10,

$\sqrt{3}\,V$ for $\sqrt{3}$. V. line 20, $\frac{\text{"V"}}{V}$ for $\frac{\text{"V"}}{100\,V}$; page 71, line 13, the word "twice" should read "4 times"; page 77, $\frac{M}{S}$ shown for $\frac{B}{S}$ in two places; page 82, line 22, the word "network" is omitted; page 85, the letter "o" is omitted from the righthand diagram in Fig. 42; page 91, line 16, "x_2" for "x_1"; page 175, line 8, the insulation resistance is given as 2 ohms: this obviously means 2 megohms.

W.M.N.M.

UNDERTONES OF WAR.

By EDMUND BLUNDEN.

(R. Cobden-Sanderson, London. 1928. Price 10s. 6d. net.)

The literary qualities of this volume and its supplement of "poetical interpretations and variations," have already been the subject of generous appreciation in the Press. But the book has a real military value, too.

It is the story of the personal experience of an infantry officer in France from the spring of 1916 to the spring of 1918. In the words of one of its reviewers "it is an invaluable document." This is true, because it gives us a wonderfully written description—not overstated—of the life of many another such subaltern in the mud of Flanders and the chalky slime of Artois, and it is well that it should have been written—lest we forget.

The author, little more than a schoolboy fresh from Christ's Hospital in Sussex, joined one of his county battalions in the trenches near Festubert, and served with it, or the brigade of which it formed part, in all the best-known sectors of the British Front. Going through all the experiences which a subaltern of more than average ability, courage, physique—and luck—went through in command of a platoon, a company, then as "maid of all work" attached to brigade headquarters—signals, bombs, musketry, rations, transport, intelligence—and for a time as "town major" of a monstrous dugout in the Ypres Salient, he is well qualified to speak. He gives us a wonderful description of it all, its joys and its horrors. The joys of the rest billets, the roadside *estaminet*, the concert party, leave and lorry-hopping; the horrors of German hates, gas, and air bombs.

A man of independent character, he was "up against it" more than once with his superiors and "the staff." He gives us a very good idea of the attitude of the temporary officer to the powers that be, softened though it was by time, knowledge and intercourse as he rose to positions of greater responsibility. It is a book to be read by those who aspire to command, for it shows the necessity of never forgetting the effect of an order on the man in the line.

One of the best points in the book is the evidence of the affection of the good regimental officer for his men and of the good commanding officer for "his children," as the French would put it.

The author is a poet who has made his mark, and the supplement contains a number of short poems, written at the time and after. One wonders "how he did it" in the circumstances in which he lived.

H.B.-W.

MAGAZINES.

BULLETIN BELGE DES SCIENCES MILITAIRES.

(1928. TOME II.—NOS. 1 TO 3 INCLUSIVE.)

Les opérations de l'Armée belge. The operations of the Belgian Army during the month of November, 1914, up to the date of the fall of Dixmude (Nov. 10th), are described in these numbers of the *Bulletin*. Events up to the evening of Nov. 3rd are contained in No. 1; those of Nov. 4th and 5th in No. 2; and those of Nov. 6th to 10th inclusive in No. 3. At this period the enemy had taken up a purely defensive attitude along the front held by the Belgians, and was carrying out a re-grouping of his formations with a view to reducing to a minimum the force to be retained on the Yser front, since it was no longer possible to carry out operations of major importance on this section of the line. On Nov. 1st the Germans held possession of the line of heights, which, between Messines and Wytschaete, commanded this region of the country; from this date onwards only some slight local advances were made by the enemy, and it soon became apparent to the German High Command that its aims could not be achieved by an offensive on the part of the troops under von Fabeck. However, in order not to abandon at once the attempt to break through the entente front S. of Ypres, and also with a view to avoiding the assumption of a purely defensive attitude on the Western Front, a reinforcement of four infantry divisions was sent to General von Fabeck, and a reinforcement of three infantry divisions was also allotted to the Ypres region, and placed under the Commander of the German III Corps. It was the intention of the German High Command that the Linsingen Group (the XV and Plettenberg's Corps) should launch a powerful attack to the E. of the Ypres Canal at Commines on Nov. 10th. At the same time, von Fabeck's troops were to recommence active operations to the westward of this canal, whilst the German Sixth and Fourth Armies were directed to hold the entente troops in their front by also assuming the offensive. The German Fourth Army delivered a violent attack against the Dixmude bridgehead on Nov. 10th, and carried it. The attack of the Linsingen Group did not mature until the 11th; heavy fighting resulted, but the Germans made no substantial progress. These operations constitute the last important offensive of the Germans in 1914 in Flanders; they were brought to a halt. The fronts of the opposing forces now gradually began to become stabilized, and the period of trench-warfare commenced. During this period the French also sent reinforcements—five infantry and three cavalry divisions—into Belgium, and, with their support, the Belgians assumed the offensive simultaneously with the enemy's aggressive movement. Minor local successes were alone obtained by the French, whose front also became stabilized.

During the November operations, French troops were pushed forward into the section of the line held by the B.E.F., and eventually divided it into two separate parts. Between Nov. 15th and 22nd, the Ypres

Salient was taken over entirely by French troops, and the B.E.F. was moved further S., taking over the defence of the entente front from Wytschaete to the la Bassée Canal.

The more important Orders issued during this period are set out in the original articles, and a short account is given in No. 3 of the *Bulletin* of the inundations carried out between Dixmude and Fort Knocke on Nov. 10th, and subsequent days.

Du rôle de l'armée de campagne et des forteresses belges en 1914. Parts 5 to 7 inclusive of the article by Lieut.-Colonel Duvivier and Major Herbiet are published successively in these numbers of the *Bulletin*. In Part 5, the authors of the original article describe the manner in which the operations of the German First, Second, and Third Armies were influenced by the existence of the fortified position at Namur during their eastward advance. A table is given showing the strength of the German troops held at Namur and in the Entre-Meuse by the Belgians on each of the days from Aug. 20th to 25th inclusive. The French Fifth Army, it is claimed, was, during the fighting on the Sambre and the Meuse, able to manœuvre with a degree of freedom which would not otherwise have been possible only by reason of the fact that the fortified position of Namur afforded secure protection to the flanks of the French troops engaged with the German forces in this region. The Namur forts hindered the Germans in their pursuit of their enemy in the Entre-Meuse and the Meuse. Further, the Belgian troops which had withdrawn successfully from Namur, and retreated southwards into France, by their presence in the neighbourhood of Bioul, covered the outposts of the French I Corps, then between Ermeton and Anthée, and also the right flank of the French X Corps, during the night of Aug. 23rd/24th. These Belgian troops also opposed the heads of the columns of the German Second and Third Armies engaged in pursuit of the French, and played the *rôle* therefore of a rear-guard to their retreating allies.

In Part 6 is begun the account of the operations in the Belgian theatre that followed the phase of the campaign, known as the *Bataille des Frontières*, which ended on Aug. 23rd. An account is given therein of (*a*) the movements of the Belgian Army, and (*b*) the *rôle* played by it, during the second phase of the war in the Belgian theatre; particular attention is called to the influence which the fortified position of Antwerp had on the operations during the period from Aug. 23 to the victory on the Marne, and to the Battle of the Aisne. The first sortie from Antwerp (Aug. 25th-26th) is described, and an account is given of the circumstances in which von Moltke created the German Seventh Army under von Heeringen on Sept. 5th; it became known as the "Belgian Army," and was directed to adopt protective measures against attacks on the Germans from Antwerp, and to drive the enemy from Western Belgium and the adjacent region of Northern France.

The account of the operations in the neighbourhood of Antwerp is continued in Part 7. The second sortie from Antwerp (Sept. 9th to 13th, 1914) is described in some detail, and the reactions of the events in Belgium on the Battle of the Aisne are discussed. An account is given of the Siege of Antwerp and of the Belgian retreat to the Yser. The influence that the resistance put up by the troops in Antwerp had on the events which took place in Flanders in October, 1914, is also discussed.

Utilité et rôle de la cavalerie. This article, which appears in No. 1 of the *Bulletin*, is based on the evidence given at its 15th meeting, on Feb. 17th, 1928, by Lieut.-General de Longueville before the *Commission Mixte* appointed to report on the organization, etc., of the Belgian Army. It is an able and vigorous defence of the cavalry arm, and contains powerful arguments, supported by references to the important part played by the entente cavalry in various theatres during the Great War, for the retention of this arm in the Belgian Army.

Notions générales sur les transports militaires par chemin de fer. This article appears in No. 1 of the *Bulletin*, and is contributed by Major Lebert, of the Belgian General Staff, who points out that prior to the outbreak of the Great War a number of military writers had foreseen that railways would play a prominent part in wartime. However, it was practically only the use that would be made of this means of transport during the mobilization and concentration periods that had been closely studied; sufficient experience was not then available to permit of definite instructions being drawn up as to the manner in which railways should be utilized during the progress of a campaign. Major Lebert states that, contrary to what was assumed in Belgium would be the case, the Great War has shown that for the transport services an organization is required which consists partly of a military element and partly of a civilian technical element. The original article has been contributed with a view to providing soldiers with some general ideas on the use of railways for military purposes, and to show what results can be expected, from this means of transport, particularly where a small army is concerned.

Napoléon Ier. Sa vie et son œuvre. The concluding part of the article under this title contributed by Major F. Delvaux is published in No. 1 of the *Bulletin*; the period immediately prior to the creation of the Empire and the Imperial Régime up to the date that final disaster overtook the Emperor on the field of Waterloo, are dealt with.

Les Fortifications permanentes actuelles de l'Allemagne. This article, which appears in No. 1 of the *Bulletin*, is based on a contribution with a very similar title which was published in the *Revue Militaire Française* for April, 1928. The position of affairs on the Western Frontier and on the Southern and Eastern Frontiers of Germany are briefly described. The terms of Arts. 180 and 196 of the Treaty of Versailles, which forbid the Germans to strengthen their frontier defences, were, it was alleged, being violated by them. In consequence, negotiations were entered into by the Powers interested with a view to clearing up the matters in dispute, and resulted in an agreement on the subject. The terms of this agreement—dated January 31st, 1927—set out the interpretation to be placed upon the two Articles above-mentioned, and is reproduced, together with the text of these Articles, in the original article.

Les Chars de Combat. Part 6 of the article under this title, by Major Liévin, is published in No. 2 of the *Bulletin*; particulars are given therein of tanks in use in the Italian and British Armies.

Historique du Génie. The first two parts of an article on this subject, by Lieut.-Colonel Coppens, appear in Nos. 2 and 3 of the *Bulletin*, attention being called to the very considerable increase that has taken place in the engineer arm in modern armies during the past quarter of a

century. In the first part, the history of the arm from the date of its creation in very ancient times down to the period of Maurice de Nassau is traced: and the nature of the work entrusted to this arm in the campaigns of far distant days is also briefly touched upon.

The second part contains brief biographical notes on Maurice de Nassau (1567–1627), and Sebastien le Prestre de Vauban (1633–1707). It was during the wars of Philip II., and his successors, in Holland (1566–1625) that a great impetus was given to developments affecting the art of the military engineer. It was largely due to the influence of the Princes of Nassau that the famous school for the study of fortification and siege warfare was founded in Holland. Maurice de Nassau took a deep interest in this school, and did much to further its development. In the account given of Vauban's life, stress is laid on the great difficulties he had to contend with, and the prejudices he was up against when he attempted to create a permanently organized Corps of Engineers; his efforts in this direction only met with partial success.

Sappers will find much in these articles to interest them.

Le transport de nos chars de combat. The original article, which appears in No. 3 of the *Bulletin*, is contributed by Lieut. de Greave, who points out that the low speed at which tanks travel ordinarily under their own power is a grave disadvantage, and detracts from their value as a military weapon. He describes some of the steps which have been taken to remove the disability in question, and gives particulars of motor-vehicles which have been designed for the rapid conveyance of tanks from one locality to another distant one. The article is illustrated.

W.A.J.O'M.

COAST ARTILLERY JOURNAL.

The September number contains a long article on the Vicksburg campaign for the Mississippi River, by which Grant cut the Southern States in two and interfered with their reinforcements and supplies. In this he was greatly assisted by a daring raid carried out successfully by Grierson with a small brigade of cavalry on the Confederate communications: this was one of the great cavalry exploits of the War, and prevented early concentration of the Southern reinforcements, and thereby contributed largely to the success of Grant's major operation.

Also an interesting story of the long fight for the possession of the Coast Forts in Connecticut, between the Dutch and English, and later the Americans, from 1614 to 1781.

The Tacna-Arica question, the Alsace and Lorraine of South America, is described, and shows how an ill-considered doctrine of acquisition may lead a country into difficulties quite unforeseen and unforeseeable.

By the Monroe doctrine, the United States declared her intention to guarantee all Republics of the Western Hemisphere from aggression or interference by European Powers. From this it has followed that she has announced her intention to assist by arbitration, and if necessary by armed intervention, in maintaining stabilized government therein, in settling international disputes and in furthering their progress and welfare.

Tacna-Arica is a territory bounded on the north by the Peruvian oil

fields, on the south by the Chilean nitrate provinces of Iquique and Antofagasta, and on the east by Bolivia, which last country has no longer any outlet to the sea. In 1880, Antofagasta with its seacoast was Bolivian, while Iquique and Tacna-Arica belonged to Peru. In 1883, as the result of a successful war of aggression, Chile took Antofagasta from Bolivia and Iquique from Peru, together with the control of Tacna-Arica from the latter, for a period of ten years, after which a plebiscite of the inhabitants was to determine whether the province should revert to its original owner or remain with Chile.

The territory is of small intrinsic value at present, but each country desires it as a buffer to protect her richer fields from the cupidity of her neighbour. And in ten years many changes may be wrought under such conditions.

At the end of the period of waiting, neither of the countries would agree to the terms suggested by the other for the plebiscite. Chile demanded that all the Chileans then in the province should be given a vote, and thereby hoped to swamp her opponent. Peru, on the other hand, contended that only the original residents should be allowed to vote. The dispute was offered to the Pope and the King of Spain for arbitration, but both wisely declined the invidious invitation.

After twenty-seven years of futile discussion, during which Chile was obviously gaining ground at the expense of Peru, the latter severed diplomatic relations with the former. After the Great War Peru, as an "associated nation," disavowed the old treaty and submitted the case to the League of Nations. This publicity did not suit Chile at all, so she invited Peru to reconsider the question. Peru promptly replied with a proposal that the United States should be asked, under the terms of the Monroe doctrine, to arbitrate forthwith. As this arrangement then entirely suited the creed in vogue at Washington, the final claims and counter-claims were filed and presented to the President in 1922.

The award was eventually published to the effect that the plebiscite must be held: that during the plebiscite all power must be in the hands of Chile; but that the Commission should consist of a Chilean and a Peruvian, with an American to act as president. The result looked like a walk-over for Chile, and was taken by both sides as such. Peru immediately entered a protest, and it began to dawn upon the United States that a quicksand might be yawning in her path.

General Pershing was detailed as American member and president of the Commission; he directed that the Peruvians should be granted equal rights with the Chileans, and that a large number of Chilean troops should be withdrawn from the province before the plebiscite was held. This appeared to be but the pious aspiration of a cloistered mind.

April 15th, 1926, was named as the date upon which the final vote was to be cast. Unfortunately, General Pershing fell ill and had to return to the United States before that date, and General Lassiter was detailed to replace him. The new president arranged that every polling district should be under the supervision of a United States Army Officer as president, with a United States Sergeant as secretary and another Sergeant as sergeant-at-arms, besides the Chilean and Peruvian members. He furthermore instituted a school, at which all the United States officers and N.C.O.s received a month's careful instruction in their duties and

responsibilities, showing that he thoroughly realized the difficulties to be overcome.

The day arrived and, as was expected, the Chileans did their best to control and influence the voting by registering all the Chilean inhabitants and suppressing the Peruvians, so that, in many places, rioting and demonstrations occurred. In the end, General Lassiter became convinced that a fair plebiscite was quite impossible to obtain.

As a result, the Tacna-Arica question is not yet settled, and promises to cause much hardship and heartburn in the future. It would further appear that favourable conditions for a fair election are impossible at present unless—and herein opens the pitfall in the path—the whole territory is neutralized by a benevolent and capable foreign power. This condition at once produces the spectre of Cuba, the Philippines, Nicaragua, and points to the same result.

Will Peru rather demand permission to put her trust in the League of Nations, and, if so, how will the United States view the incursion of the League's activity into the southern part of her continent?

The October number begins with an article on Seacoast Defence to stress the necessity of the maxim that a fortress must not be commanded by the Senior Coast Artillery Officer while he commands the Coast Artillery as such. In other words, territorial command by a functioning artillery officer is unsound. The author points out that the United States Training Regulations and Artillery Regulations do not bear out this maxim.

There follows a description of the genesis and growth of the War Industries Board in America during the Great War, with the following functions:—

1. The creation of new facilities and the disclosing and opening up of new and additional sources of supply.
2. The conversion of existing facilities, where necessary, to new uses.
3. The studious conservation of resources and facilities by scientific, commercial and industrial economies.
4. Advice to the several purchasing agencies of the Government with regard to the prices to be paid.
5. The determination of priorities of production and delivery, and of the proportion of any given article to be made immediately accessible to the several purchasing agencies when the supply of that article is insufficient, either temporarily or permanently.
6. The making of purchases for the Allies.

The writer concludes by stressing the utmost importance of retaining a peacetime organization, based on the experiences of the wartime agencies, to be formed in suitable divisions and sections, so that it might be possible in case of future war to create promptly an organization of all the industries and resources of the nation. The principle of the selective draft to be applied to every grade, to the business army as well as the fighting forces, so that the whole life of the nation, economic as well as military, shall be conscripted.

Thus may be avoided that enemy who can undermine the will to war

so rapidly, the popular conviction of widespread exploitation and profiteering.

A short sketch of the military situation of Japan describes the racial characteristics of the Japanese as resourceful, emotional and still almost fanatic, less nervous and better able to endure discomfort than the Anglo-Saxons, but with smaller physical endurance. They have no sense of humour, and are not pioneers. The increase of population is alarming to an already overcrowded nation; a family of ten children being considered only medium-sized in Japan; but she can no longer feed them, and she has already been obliged to import rice.

In an article on "War and Human Nature," the following quotation may be of interest:—

> "There are nearly always at work in any nation, whether at peace or at war, certain constant forces tending in the direction of autocracy, caste formation and an aristocratic differentiation, a pyramiding of the social structure, a conification or pointing upwards, making the upper classes fewer in percentage to the total and at the same time more aloof . . . It depends upon the gigantic force of heredity, and upon the fact that in marriage, like tends to mate with like. . . . A savage people is never highly conified.
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> "With the accumulation of property, however . . . there takes place the handing on of riches to the next generation. Men of wealth, success or ability bring their children to marry one another. Biological heredity is at work, and by a process of selection, a caste is formed of individuals endowed with an excess of precisely those qualities that their ancestors have exhibited during their own lives, namely, ambition and a love of power and leadership, glory and family pride.
>
> "These forces may culminate in aristocracy. When they do, we have a national structure very well adapted to belligerency and very prone to fight.
>
> "As far as the evidence from European history is concerned, if war is diminishing, it is not diminishing much . . ."

D.M.F.H.

MILITÄRWISSENSCHAFTLICHE UND TECHNISCHE MITTEILUNGEN.

(*March–April*, 1928).—*The Use of Artillery in the 11th Isonzo Battle.* Lt.-Col. Heinzel gives in detail the events of the 18th–22nd August, 1917, as they affected the artillery group under his command on the front of the 48th Austrian Division. He makes out a good case for his claim that the artillery had a considerably larger share than usual in the success of this purely defensive battle. His group had also their share of the casualties, viz., 50% of the personnel killed and wounded, and eight guns destroyed by direct hits.

The author also points out that many a good fight is insufficiently appreciated because of its having no strategic effect. The case in point is the attack by the Italians on the Karst plateau, which he describes. It does not, however, follow that a successful defensive battle which leaves the opponents in the same relative position as before has no

strategic effect. The tactical success in this instance may avert strategical disaster, it may have a most important negative strategic effect. A more striking example, because the negative strategic effect is more apparent, was the attempt on Béthune made in April, 1918, by seven German divisions against the British 3rd, 4th and 55th Divisions, when it had become imperative for the Germans, as a first condition of a further advance on and beyond Hazebrouck, to widen the breach of their breakthrough.

French War States. From the *Revue militaire française* certain interesting figures are taken of the yearly average numbers of French combatants in the field :—

1915	...	2,120,000	1916	...	2,210,000 (includes one extra class).
1917	...	2,000,000	1918	...	1,702,000 (includes the 1919 class.)

The employment of French Divisions in 1918 is also worked out, from which it appears that on the average each division spent 27% of its time on a fighting front, 46% on a quiet front, and 27% " in complete rest." The choice of the latter expression as a paraphrase for " out of the line " is so unhappy as to suggest that the author of it must himself have remained in the line during the whole war ! The figures are here utilized for the purpose of adding one more leaf of glory to the laurels of the Germans, on the grounds that they got no rest at all—a statement to be accepted with reserve.

Railways in War, by Gen. Ratzenhofer (concluded). The principles of an appropriate and systematic management of mass-transport by the military railway authorities are timely and adequate information of the plans of the G.H.Q., and an exact knowledge of the capacity of the railways, of the composition, distribution and march-readiness of the troops, and of the requirements as regards detraining.

This exact knowledge of the " own situation and intentions " was completely available during the preparation for war and at the commencement of the forward movement. After the first few weeks of war, through a lack of liaison in high places and through enemy action, it was disturbed and in definite areas often completely lost.

Every success in dealing with mass-transport in war rested upon exact attention being paid to these principles, and every failure was due to their non-observance.

All mobilization schemes were based upon the railway-schemes drawn up by the military and civil railway authorities in peace and revised yearly, in winter. The railways had their work mapped out for them in peace, up to the 20th day of mobilization in back areas, and in forward areas, on account of secrecy, up to the 5th day. This very thorough piece of work afforded the only possibility in peace of practising together those military and civil officials, who in war would be entrusted with the direction of the military railway staffs.

What happened was that Scheme B, partial mobilization and forward movement against Serbia, started on July 27th with about 70 trains a day. On August 2nd, preparations were started to change over to

Scheme RB, to be followed on August 4th with complete mobilization against Russia. By August 16th, there were 800 trains of 50 wagons each —the length of 250 miles of track—in daily movement according to plan. The salvation of the scheme lay in a programme prepared through years of work in peace.

Nothing to compare with this orderliness ever happened again. Improvisation was henceforth stamped on all movements.

Light Machine-guns, by Capt. Däniker, Swiss Army. The light machine-gun has a very definite position to fill, and nearly all armies are at present occupied with this question. The author lays down its essential requirements, and then the limitations which must be imposed upon it. He comes to the conclusion that efforts to improve the light m.g. by assimilating it to the heavy m.g. are a complete mistake, since they rob the light m.g. of its character and add to it a complexity which prevents it from solving the battle-tasks for which it was created.

The next article, "The Light Machine-gun Breda," compiled from a pamphlet of the Società Italiana Ernesto Breda in Milan, gains thus in interest, since it describes a m.g. of 20 lb. weight and having the rifle appearance, which, being a bolted recoil-loader with movable barrel, introduces for the first time among light m.g.s properties hitherto restricted to heavy m.g.s. The remark, "for the first time," would appear to ignore the Madsen and the Swiss light m.g. 25 (Furrer), which have already left the gas-pressure loaders, but the claim remains of having improved the light m.g. while retaining its character.

Armoured Cars, by Major Heigl (*continued*). The instalment in this number is chiefly remarkable by containing photographs, sketches and certain points and figures concerning the Czecho-Slovakian armoured-cars, P.A. I and P.A. II (known, from its shape only, as the Tortoise). P.A. III has also appeared, differing from P.A. II in that its outside curves are provided by armour built up of separate small pieces, triangular and four-cornered. This change has made possible a reduction in weight from 6½ to 5 tons. Major Heigl calls the P.A. II "the best armoured car we know," which probably means in existence.

The remaining photographs are of older types of armoured car: the Bianchi (Italy and Hungary), the Ansaldo (Italy and Czecho-Slovakia) and the Austin (Russia and Poland), of a late pattern of Citroën-Kegresse chassis, and of a Pavesi (high-wheeled) armoured tractor negotiating a trench. The two latter are to illustrate short notes on these systems. Six-wheeled vehicles are also dealt with, and the principle of the Pavesi patent, showing how flexibility is given in spite of the large heavy wheels, is shown by sketches.

Modern Anti-tank Weapons. This article, illustrated with several sketches, is based upon an article in the December number of the *R.T.C. Journal*, but has been considerably enlarged by Major Heigl since. The photographs are good and clear. They include: the 13·2 mm. Hotchkiss m.g. on a light field carriage; the 2 cm. gun built at the Hague for use on submarines, and later mounted on a German maxim m.g. carriage for use against armoured-cars; the 37 mm. Bofors infantry gun; the 47 mm. Bofors as anti-aircraft gun; and the new 70 mm. Schneider infantry gun.

(*May–June*, 1928).

The Plans of Operations of the Central Powers for the Autumn Campaign, 1914. This is one of Capt. Wisshaupt's excellent articles, in which he combines instruction with history by discussing the problems and choices which lay before the Commanders. The period covered, from the 18th September to the 27th October, is full of interest, since it starts from the time when the Russian "steam-roller" stopped on the San, and the Austrians were reinforced by Mackensen's (9th German) Army from East Prussia, and includes the successful Austro-German advance to the line of the Vistula, and the Russian movement from the north, which turned Mackensen's left flank and caused the general retreat.

The Austro-Hungarian Operations for the Occupation of the Ukraine, 1918. In Christmas week, 1917, after three years' service in a German Army, the 12th Austro-Hungarian Corps was transferred from Lithuania to Eastern Galicia. There they received two Austrian divisions to replace three German divisions, which, released by the armistice with Russia, were already on their way to the Western Front. The 12th A.H. Corps was then used for seizing the Ukraine, which, with plenty of fighting against the Bolsheviks, they carried out as follows :— 28th Feb. to 18th March, operations between the Dniester and the Bug, and the capture of Odessa ; 19th March to 13th April, operations between the Bug and the Dnieper, and the capture of Ekaterinoslav ; 18th April to 13th June, occupation of the Donetz coalfields, the Crimea and Sea of Azov. From June to November they assisted in the establishment of the Ukraine Government.

The article deals with a new method of conducting war—railway warfare ; and for this, since the Russian railways were cut off from the Austrian by a change of gauge, everything had to be improvised. The rolling-stock was in a deplorable condition, couplings were defective, and many of the locomotives "swayed like overladen hay-wagons." The Austrians, with improvised railway staffs, would have fared even worse than they did, but for the Russian railway personnel—unpaid for months—who stuck to their posts and served their new masters. Trains in taking troops forward had to follow one another by sight ; accidents were unavoidable ; and the first train always ran a good chance of being ambushed.

Odessa itself was taken in this fashion, after an airman had reported 15 larger warships and 20 torpedo-boats in the harbour. This fleet saved much embarrassment by putting to sea on the arrival of the Austrian troops in the town, all excepting one cruiser, which, delayed only for a repair, had fortunately disappeared by the next morning !

The Building of Heavy Floating Bridges, by Lt.-Col. Kern. The object of this article is to introduce to Engineer officers the building of heavy floating bridges which, on account of the time they have to last, must be built so as to allow for floods. The design and execution of such bridges demands knowledge which is not to be found in text-books (*vide* note below), but which has been gained by practice in war.

An example of a bridge which was built over the Save above its junction with the Drina is then set as an exercise.

Data :—River 343 metres between banks ; right bank 4·5 metres, left bank 4 m., and flood-level 3·5 m. above present water-level ; lowest water-level 2·5 m. below P.W.L. ; right bank, sandy, slopes at 1 in 5·5 for 54 m., will take 5 pile-trestles, 9 m. centre to centre ; left bank, loamy, vertical 4 m. and then falls 1 in 5·5, will take 3 pile trestles, as above.

Width of roadway, 6 metres.

Max. load on each trestle, 36 tons.

Max. load on each road-bearer (9 m. long, 8·5 m. between points of support) starting at left-hand point of support, wt. *nil ;* at 1·05 m., wt. = 2·25 tons ; at 4·25 m., wt. = 4·5 tons ; at 7·45 m., wt. = 2·25 tons ; at 8·5 m. (right point of support) wt. *nil.*

Available : Cut timber as required.

16 lighters, 58 m. long, 8 m. broad, 2·2 m. water-line to gunwale unloaded, made up in pairs, 24 m. from outside gunwale to outside gunwale. A cut to be arranged for.

Ordinary pontoons are available to carry the ramp of left bank where the water is too deep for trestles.

Labour available :—Engineers, 5 officers, 5 serjts., 150 other ranks ; unskilled, 2 officers, 160 other ranks.

Required : Design, calculation, details of ramps, details of floating portion, materials required, tools required, working parties, time-table.

The exercise has been printed separately and can be obtained with full solution from M. und T. Mitteilungen, Stubenring 1, Vienna I.

Note.—The *German* Heavy Bridging Manual, H. Dv. 222 Part III a, however, goes into the subject thoroughly. Publisher, E. S. Mittler & Sohn, Berlin.

Prize Competitions as a part of Individual Training, by Lt.-Field-Marshal von Ostrymiecz. These competitions, now universal in the Austrian army, were, in the author's division at least, held periodically during the War. A junior N.C.O.s' School consisting of two men per company throughout the division was the focus, from which there radiated into the trenches a freshness and an awakened interest in the sporting side of weapon efficiency. From individual improvement rose a higher standard of weapon efficiency all round, expressing itself in two directions, less casualties suffered and more casualties caused.

The Development of Artillery Material since 1914. Major Heigl resumes his series with an article on " Heavy Guns on Position-mountings." As he excludes naval guns, coast-defence and other fortress artillery, he is dealing with the small, but very interesting, class of heavy guns used in land-warfare on movable position-mountings. The use of heavy artillery before the War was supposed to be the bombardment of fortresses, since the mobility of long-range guns ceased at the 6". In fact, the problem of mobility above the 6" was so difficult to solve that even with the naval 6", railway-mountings were used by all three powers on the Western Front—France, England and Germany. Hence, apart from railways, the number of mountings to be found in all armies is small.

The descriptions of three very different mountings are then given, with drawings and photographs:—

(1) The *affusto a coda*, or mounting consisting of two girders pivoted in rear by a heavy spur sunk in the ground, of the Italian 152 mm. L45 gun.
(2) The solid platform, taking to pieces for transport and requiring a pit 4′ 6″ x 17′ 6″ x 20′, of the Austro-Hungarian 24 cm. gun M16.
(3) The double recoil of the French 220 mm. Schneider gun M17.

Finally, on the plea that so many apparently immovable coast-defence guns were used in the War on different land fronts, the article closes with a description of the American 16″ gun, of which the shell weighs one ton and can penetrate 14″ of armour at 31 miles. Ten of these guns are in position: New York 2, Boston 2, Sandwich Islands 2, and Panama 4. Eighteen more are being provided, for Panama 4, and the remainder for San Francisco and Chesapeake Bay.

War and Criminality. The Carnegie Institute for Peace has left no stone unturned in its efforts to show up war in its worst aspects. In pursuit of this object the Institute brought about the appointment of a Commission for investigating criminal charges against officers of the old Austro-Hungarian army.

It will be of interest to officers of all armies, but it will not surprise them, to learn that of 484 such complaints unearthed by the Commission, eight only led to criminal proceedings, and of these six resulted in acquittals.

F.A.I.

HEERESTECHNIK.

(*April*, 1928).—*French Instructions on the Organization of Terrain.* This article consists of copious extracts from and notes on Part I of the *Instruction provisoire sur l'organisation du terrain*, which deals chiefly with the principles of field fortification, while Part II, to be noticed later, enumerates and describes the various works and gives instructions as to their execution.

The German reviewer finds that the general principles of the French Instructions agree closely with those laid down in the corresponding German manual, H.Dv.276, Part I. When he comes to details he finds certain differences worth pointing out. He objects to the organization by regulations of a defensive front into an advanced position, *position des avant-postes* (which the Germans only say "may" be desirable), a position of resistance, consisting of a main line, *ligne principale*, (corresponding to the German main line of combat), a line of supports and a holding-up line, *ligne d'arrêt* (which the Germans do not know). Exception is also taken to the provision of a centre of resistance as part of the defensive arrangements of the battalion, and to its sub-division into company, section and group strong points. Finally, he is not pleased with the continual emphasis which is laid on the importance of connecting up all posts and centres by means of a network of parallels and communication-trenches, provided upon a scale so lavish as to render it

impossible for hostile aircraft to determine which are the occupied and important parts of the position.

Two omissions are considered striking, that no mention is made of the necessity for adequate drainage of a trench system ; nor any of the value of inundation for creating obstacles.

The Technical Development and Present Position of the Six-Wheeler. This article of 18 pages, with nearly 40 photographs and drawings, would constitute a pamphlet in itself. Dismissing the Chevrolet as not a true six-wheeler, since its third axle was not driven, the rise of the six-wheeler is traced from the Renault of 1924, designed to show that a wheeled car could cross the Sahara as well as the Citroën-Kegresse, through the successive improvements of the Krupp 2-tonner, Daimler-Benz, Mannesmann-Mulag to the Krupp 8-tonner and the Büssing. The whole makes a suitable introduction to the W.D. specifications for a medium 6-ton lorry, and the requirements of 6-wheelers as stated by Major Kuhne in a lecture at the Institution of Mechanical Engineers. Up to date (April, 1928) twelve firms, in response to the War Office appeal, have produced 31 different types of six-wheeler, of which fourteen have been passed as fit to earn the Government subsidy of £120.

Sound-Ranging and Flash-Spotting in the Swiss Army. That a non-combatant in the Great War should have anything on this subject to teach the Germans may be surprising. The explanation appears to be that the Swiss Army was enterprising enough to take the subject up in 1917, and must have learnt much from the French.

The origin of sound-ranging is due to the astronomer Nordmann, who in November, 1914, from the Paris Observatory located a battery carrying out trials. His success was immediately exploited, and only three weeks later the first German battery was located by this means on the Soissons front.

In 1922, the Swiss Army formed a Sound-ranging and Flash-Spotting unit for every artillery brigade. As sound-ranging results are affected by temperature, the degree of moisture in the air, and above all by the strength and direction of the wind, meteorological instruments and personnel are included in the detachment's equipment.

The effect of the wind on range-measurements is so great, and wind conditions are so difficult to determine, that flash-spotting is the method preferred, especially at night. As, however, sound-ranging alone is possible in foggy weather and in wooded country, the two systems work hand in hand.

Social Politics and Technics in the Service of National Defence. Considering it undeniable that Germany's mistakes in social politics led directly to the loss of the world-war, the author indicates a number of questions regarding the regulation and organization of labour, " the home-army," which must be investigated and settled in peace in order that the nation may be able to put forth its whole strength in war.

(*May*, 1928.)—*Wireless Novelties at the Leipsic Fair*, 1928. In newspaper fashion this article starts with births and deaths. " The Funnel Loudspeaker is dead." This is true, and it was the Cone Loudspeaker which killed it. " The most important of all novelties is the

Thermo-Battery." This hoary centenarian should not, however, have crept in amongst the births. Nevertheless, it is interesting to note how conditions have conspired, after over 100 years of waiting, to give it a place in the world. Appearances, too, were all against the thermo-electric battery, holding as it does a firm place amongst the world's most inefficient converters. The specimen exhibited at Leipsic, the "Stub," takes 200 watts from the mains and renders 1·6 watts (4 volts and ·4 ampère). The Stub is manufactured by Strauss and Berliner, 20 Prinzessenstrasse, Berlin, measures about 12" x 10" x 9", weighs 11¼ lb., and consists of 176 bismuth alloy and antimony alloy couples. It can be heated also by gas, oil or spirit. The conditions which have given the thermo-battery a sphere of usefulness are broadcasting reception by amateurs, all having electrical energy readily available from plug-contacts for heating purposes, and indifferent as to the inefficiency of conversion, but desirous of being free from accumulator troubles, dry-battery troubles and transformer noises, and hence ready to welcome a source of energy for their sets, which requires no charging, which requires no attention, which does not run down, and which contributes no unwelcome noises of its own.

A new rectifier by Siemens-Shuckert utilizes the property that from cuprous oxide to copper a current will only pass in one direction. It is built up complete with a small transformer, leads and plug for taking from house-lighting mains, and is intended for accumulator charging up to ·5 amps. A larger size is promised for large batteries up to 10 amps.

The Nife-Stahl Company showed accumulators without sulphuric acid. The cells are of cast dagenite and contain an alkaline electrolyte. They need no outer covering.

Telefunken showed grid-screen valves which reduce the anode to grid capacity to a few hundredths of a centimetre, so that effective H.F. amplification of waves less than 600 metres is claimed: amplification-factor, 500.

Something entirely new was shown by the Metallicator Company. This firm concerns itself with the metal spray for weather protection, spraying molten zinc, tin, aluminium, copper, etc., from a blast pistol. For wireless instruments the same method of spraying has now been applied to wood and insulators, so that it is possible to spray the connections of, say, a wireless receiver on a sheet of vulcanite, and thus exclude all possible errors in connecting up. Wiring disappears, and without labour, mistakes and untidiness, the connected up instrument looks like a wiring diagram! The advantages to mass-production are very great.

Technical Development and Present Position of the Six-Wheeler (concluded). Describes with photographs and constructional drawings the Scammell six-wheeler, which, although it does not entirely fulfil the W.D. conditions, has been admitted to the ranks of the subsidized vehicles, on account of the extraordinarily successful way in which it accommodates itself to rough ground. There follow a photograph of the Thorneycroft 3-tonner with single-axle trailer, as extensively used in the Sudan, a photograph of the F.W.D. 6-wheeler, with all axles driven, and constructional drawings of the Vulcan 3-tonner.

Finally, the last three W.D. conditions are discussed, viz. : (4) wide range of gears, in order to guarantee the necessary road speed, as well as the maximum tractive effect over bad ground ; (5) pneumatic tyres, and (6) the necessary stability against overturning, and the clearance requisite in front and rear for negotiating steep slopes, and beneath the lorry for clearing rough ground and crest tops.

Thoughts about the Tasks of Weapon-technics, by Lt.-Gen. Baron Botzheim. This article is written for the regimental officer, so avoids all purely technical and scientific questions. The author shows how all weapon construction is more or less of a compromise between the many factors of widely different nature which influence design. All these factors are in continuous development and change in value, as well as in mutual relationship. As an example of how differently the value of different factors has been estimated, he takes the German field gun, and shows how to the chief pre-war requirements, mobility and unified ammunition, had been sacrificed what turned out to be the chief requirements during the War, viz. : increased effect, increased range, and facility of mass production. Since an increase of calibre, which would have been the most rational way of meeting the first of these demands, could not be considered while war was in progress, there was nothing for it but to lengthen the projectile. The consequence was increased unsteadiness of flight, hence worse shooting, especially at longer ranges, the endangering of one's own infantry, and affecting their morale. Also the increase of range, which, except by improved shape of the projectile, was gained chiefly by lengthening the barrel and by increased charge, without, however, thorough ballistic trials, caused both greater dispersion, and too great a strain and consequent wear upon the gun. The necessary lengthening and strengthening of the carriages and recoil parts were prejudicial to mobility. The adoption of unified ammunition, too complicated for mass production, was a chief cause of the early shortage of ammunition at the front, and of the inferior ammunition which was hurriedly turned out to make good the deficiency.

The author then goes on to show that the post-war requirements of the German field gun further emphasize the range factor, in fact " range " has become a catchword, to which other requirements are being unduly subordinated.

He makes out a strong case for an increase of calibre above the present 7·5 cm., which he says is incapable of achieving effective action against small targets like artillery, m.g. nests, etc., at 10 kilometres ; while an accurately calculated barrage attempting to work on 25 and 50 metre differences of range is a chimera.—(*To be continued.*)

The Greatest Muzzle Velocity. This is a mathematical problem, not in ballistics, but in thermo-dynamics. A first attempt results in a figure, 1,165 metres a second, which is well below the muzzle velocity of the Bertha that bombarded Paris. This, according to the *Revue d'artillerie*, must have been 1,400 metres a second. Reality again vitiates theoretical results ; as it did when an officer in the Black Watch was so far lacking in filial respect as to drive a golf ball further than the distance worked out to be the greatest possible by his father, a professor at Edin-

burgh University. The author's second attempt fortunately saves the situation by giving the answer as 1,630 metres a second.

"Gas over Germany," "Gas-protection," and *"The Air-danger and Air-protection possibilities in Germany."* These three pamphlets are a sign of the times. They mark the Paris Agreement's removal of the ban on passive air defence imposed on Germany by the Peace Treaty, and are of the nature of propaganda issued to enlighten the people as to their duties in the face of possible dangers. The first-mentioned pamphlet has already done duty once in this respect, as it is the translation of a Russian publication by the Osoaviachim or National League for the promotion of understanding of Air- and Chemical Warfare, the harrowing scenes and devastation being laid in Germany, so as to spare the Russian readers' feelings.

(*June*, 1928.)—*Theoretical Considerations on the Construction of Muzzle Brakes.* Calculations by a Hungarian engineer, which show the editor's high opinion of the German officer's mathematical powers and taste.

Starting, as last month's problem did, with the Adiabatic Law,

$$p_1 v_1^{\,k} = p_2 v_2^{\,k},$$

where $k = 1{\cdot}405$, or the proportion of specific heat under constant pressure to specific heat under constant volume, and with the velocity of the escaping gas as the base of the shell leaves the muzzle as :—

$$\sqrt{2g\frac{k}{k-1}p_1 v_1\left\{1-\left(\frac{p_2}{p_1}\right)^{\frac{k-1}{k}}\right\}}$$

the author, with the aid of Schüle's *Technical Thermo-dynamics* and Rausenberger's *Theory of Gun Recoil*, works through eleven pages of investigations into recoil without and with muzzle-brakes, and arrives at formulae to express the braking effect of the muzzle-brake and its efficiency. The stability question he appears to reserve.

French Instructions on the Organization of Terrain. Part II of the *Instruction provisoire sur l'organisation du terrain* deals with the design and execution of the works necessary for carrying out the principles laid down in Part I, and would make interesting and instructive reading for any R.E. officer already thoroughly acquainted with our own *M.E.* volumes. In this notice no review of the book itself is permissible, but those things in it will be pointed out, which particularly struck the German reviewer, either as dealing with points which have been omitted in the corresponding German manuals, or as showing divergencies between field engineering ideas and practice in France and Germany. As regards the design of ordinary fire-trenches, immediate exception is taken to the recommendation to provide loop-holes, for which the most varied types of construction are suggested, from wood and sandbags to gabions and iron, and to the statement that they considerably increase the protection of the firer, since the German experience is the contrary.

As regards the digging of fire-trenches, dismissed by the German manual in a few words, several pages are devoted to it, and go into every detail, the trace, issue of tools, marching up and lining out, intervals,

disposal of earth, relays of spades, etc. It is characteristic of the French that according to the requirements of the work they form working-parties of different units (*ateliers*) instead of using the tactical units complete.

Very peculiar appears to the German reviewer that a second method of providing fire-trenches, viz., by the aid of the sap-roller, is not only mentioned, but described in detail. The single and double sap-rollers of the German 1906 manual are used, not for broadening the trench as formerly, but for deepening it, *i.e.*, for converting it from the standing fire-trench to the standing fire-trench improved.

The provision of shelters under the parapet is arranged for as follows: before the trench is started, the ceiling is laid out on the ground in position, first two wall-plates and then, resting on them and at right angles to them, a layer of joists (or *bullis*). The trench is then dug, and subsequently the shelter is made by digging out the earth under the roof. In the case of more solid dug-outs, the bursting-layers are made of 8" diameter round timbers, laid touching one another, and laced together with wire. For the bursting-layers of shelters in rear, small reinforced concrete slabs are used, with metal lugs in their rounded corners. When in position, these slabs are fastened together by stirrups of soft steel, which are tightened up with a special key. German war experience is against these slabs.

The reviewer commends the idea of connecting a dug-out with the open air by means of a boarded shoot, so that in case of the entrance becoming blocked, air and provisions can reach the entombed.

Diametrically opposed ideas are to be found as regards revetting. The French devote seven pages to the making of hurdles, fascines and gabions, while the German instructions announce surprisingly, "All revetting of trench walls is harmful." This dictum explains many a German trench!

As regards heavy machine-gun positions, the French order, and the Germans forbid, connections between the gun-positions, O.P., ordinary shelter, alarm shelter and the main trench system.

The emphasis of the necessity for making connected works is striking, thus "The advantages must always be stressed of works which are connected: they far outweigh the dangers which might arise from the easier discovery of those works by the enemy." Again, "One cannot strive enough against the inclination to content oneself with single shelters or with shelters for small numbers of men." Here the Germans take entirely opposite views.

In spite of the instructions covering 200 pages, they do not contain much of what is in H.Dv.276 Part II, and in H.Dv. 316, the corresponding German manuals. For instance, they omit tank-obstacles, the overcoming of obstacles, the putting of places into a state of defence, gas-protection of shelters, camouflage, dummy positions, water supply, the destruction of roads, etc. On the other hand, they contain in profuse detail much which the Germans take for granted, or which they have struck out as obsolete. Especially strange appears to the Germans the emphatic demand for the creation of internally-connected closed defensive posts.

The reviewer also criticizes the division of the instructions into Part

I, description, and Part II, execution, since this leads to repetitions, swells the instructions, and makes them more difficult to use.

The Investigation of Materials by Röntgen Rays. Röntgen himself in 1897, two years after he discovered the Röntgen rays, examined a gun barrel by their aid, and pointed out how these rays might be utilized for proof purposes. It is, however, only recently that this use of them has begun to be developed. Apart from radio-activity, Röntgen rays originate from surfaces, glass or anode, under electronic bombardment, the greater part of the kinetic energy reappearing as heat, while a small portion becomes fluorescence, and re-radiation in a new form (the Röntgen rays) taking place in all directions from the bombarded surface.

For practical purposes the rays are produced in two kinds of tubes, ionic, exhausted to 10—4 mm. of mercury, or electronic, which are practically gas free, say, to 10—7 mm. of mercury of vacuum.

There are three methods of using the rays for proving materials, and they all require enormous voltages.

(1) The Absorption Method. This depends on the property of the rays of penetrating solid substances, but with partial absorption; thus defects, flaws and cracks can be discovered, since radiation is weakened at these spots in varying degree. Such weakening is observed either directly by projection on a screen, or by record on a photographic plate, owing to the property of the rays of reducing AgBr to Ag. Potential is necessary up to 200,000 volts to cause penetration of bronze to a thickness of 2", iron of 3", and aluminium of 1".

These thicknesses apply to photography only, considerably less being the maxima for observation by screen-projection.

(2) The Interference Method. This depends upon the property of Röntgen rays of being refracted when passing through crystalline substances. In this case flaws are discovered by variations, lines or spots, occurring among the circles characteristic of crystalline structures. Voltages are from 30 to 80 kv.

(3) Spectrum Analysis. As in the optical spectrum, so in the Röntgen spectrum, each element has its characteristic lines. Qualitative, and in favourable cases the quantitative, composition of the material can be determined. There is no question, at any rate at present, of this method supplanting chemical methods; but if not so accurate, it is certainly much quicker. Voltage required, up to 100 kv.

In general, the proving of materials by Röntgen rays is as yet undeveloped, but its further development will open up many new fields. Credit is due to the German Metallurgical Society for their pioneer work, for instituting lectures and for awakening widespread interest.

The German 1/50,000 *Map (the 2 cm. Map).* Most European countries have maps already of 1/25,000 and 1/100,000 or their equivalents; nevertheless, there is a general demand for a map on an intermediate scale. In France, a new 1/50,000 map has been decided upon, and is rapidly being produced. In Switzerland, the same. Long before the War, Germany had started with the issue of a 1/50,000 map of certain

districts much frequented by tourists. Prussia had prepared such a map of Berlin and neighbourhood in 12 sheets. Bavaria had long since produced an atlas of 112 sheets of the same scale, and 55 such sheets had been produced by Würtemberg. Also, Saxony and Hesse had started on similar lines. Thus the idea gained ground that there should be a map of Germany at 1/50,000, and experimental sheets were got out. Finally, the Assistant Counsellor for Survey took the matter up, and had a sample prepared by his mapping committee in order to prevent maps of different appearance being produced by the different states, as was unfortunately the case with the 1/25,000 map.

The writer then gives the proposed details of the new map, with which he agrees except in the following particulars :—

(1) Maps are to be bounded by 12 minute parallels of latitude and by 20 minute meridians. He considers this makes them too small for military purposes, and recommends 15 minutes by 30 minutes.
(2) He thinks it a mistake to give the names of rivers and streams in blue, as insufficiently legible.
(3) For military purposes four conventional signs for bridges are required : up to 6 tons, up to 12 tons, up to 22 tons, over 22 tons.
(4) Kilometres should be marked on railways as well as on roads.
(5) He recommends stump-shading in addition to the contours.
(6) Heights of places, which stand out prominently, should be underlined or marked in heavier figures.

He approves of the introduction, on the margin, of scales of slopes, permitting one to transfer the distance apart of two contours, and for the appropriate V.I. to read off the slope in degrees. He hopes this may be extended to all other maps.

Thoughts about the Tasks of Weapon-Technics (continued). The theoretical solution of the problem would be to replace the 7·5 cm. field gun by a new field gun of calibre 8·35 to 8·5 cm. if horse-drawn, range 13 km., muzzle-energy 180 metre tons ; if mechanized, of calibre 8·8 to 9 cm., range 14 km., muzzle-energy 230 metre-tons. Practically, it is doubtful if any country, except possibly the U.S.A., would face the cost of a change of calibre of field gun, especially considering the large war stocks of guns and ammunition still in existence.

The post-war urgent demands for standardization to cheapen manufacture and to facilitate mass production led undoubtedly to real progress and to improvements, but also to not inconsiderable compromises and artificialities. Much time and labour were spent by constructors in all countries in trying to meet demands which the people who made them would, if they had been technically trained, have seen from the first to be incapable of complete solution. The reaction in this respect is now making itself felt in several countries. Experience has taught us, before making fresh demands on war-technics, to consult the technical experts and constructors and to allow them their say. They, on their part, must strive to seek out new ways and means of creating the technical principles for ever-increasing demands on weapon-technics.

The present-day movements from which the weapons of the future will be developed are: the organization of air forces for independent action, including transport of troops and supplies (England, France, Italy, Poland, Czecho-Slovakia, etc.); mechanization, motorization and armouring of the means to battle (England, France and her vassal states); the laying out of prepared battle zones as boundary protection (France, Belgium and Poland); the organization, already in peace, of the protection of the population against air bombs and poison gas (Russia, Poland, and England).

The above movements are then discussed, and the author goes on to ask: With what means and forms of fighting shall we have to reckon in the more distant future, in five to ten years' time, and what are the tasks for weapon technics which will arise therefrom?

(*To be continued.*)

F.A.I.

REVUE DU GÉNIE MILITAIRE.

(*September*, 1928.)—There is a continuation of the article on the inundations on the Belgian front.

On November 3rd the bridgehead at Nieuport was reoccupied and the key to the complicated hydraulic system was again in Belgian hands. In December, 1914, a scheme was undertaken with the object of destroying all the crossings over the Yser Canal, which were in German hands. This was effected by opening all the ebb gates in the Ypres lock (situated at the end of the Yser Canal, where it joins the Channel of Nieuport), keeping the floodgates closed by means of ropes, and waiting for a low tide to obtain a large difference in level between the Yser and the Channel. The ropes were then cut and the floodgates opened, suddenly causing a violent current in the Yser, which carried away several foot-bridges.

At the same time, steps were taken to limit the extent of the inundation southwards, for water had naturally flooded all the land to the north-west of Dixmude. This was done by making a continuous bank from *borne* 16 on the left bank of the Yser to kilo 5 on the railway embankment, the area south of the bank being freed of water by means of the western ditches of the Furnes *watering*. The level of this inundation was regulated by manipulating the floodgates at the end of the Noordvaart Canal.

In August, 1915, severe damage was done to the Furnes and Ypres locks by German gunfire, causing anxiety for the weir of Noordvaart, on which the whole system of inundations depended. Its destruction would have left the flooded area at the mercy of the tides, the action of which might seriously have affected the security of the railway embankment, and this was the essential feature of the main Belgian position. So, to render this inundation independent of the Noordvaart weir, an auxiliary dike was made connecting the St. George dam on the Noordvaart Canal to some high ground on the north side and to the railway embankment on the other side. The construction of this dike was brought to a successful conclusion in three weeks under great difficulties. Work could only be carried out at night. The ground on which the dike was built was under water, whilst the sandbags used for its construction were filled on the west side of the railway embankment with waterlogged

earth. It was called the Dumont dike after the name of the energetic subaltern who superintended its construction.

A problem which had to be faced was that of the drainage of the ground west of the railway, which was occupied by the Belgian Army. This land was drained in the first place by the Koolhof Canal, the siphon under the Furnes Canal and then through the lock on the old Furnes Canal (see plan in December number of *Royal Engineers Journal*), since the bridge opening over the Veurne Ambacht had been closed since December. But the flow in the old Furnes Canal was very slight, and in winter and during heavy rain was insufficient. Evacuation of water was therefore arranged through the Loo Canal, either by the sluices connecting direct with the canals or ditches, or by powerful steam pumps installed at the Slopgat and at the Beverdyck. Water passed from the Loo Canal to the Furnes-Nieuport Canal, and found the sea through the Furnes lock and weir. But after the destruction of the latter in 1915, water was passed to the sea through the Oostvaart lock and the Noordvaart weir, the St. George barrage being kept shut. This operation was facilitated by the existence of the Dumont dike, which isolated the Noordvaart inundation.

The Loo and Furnes Canals, primarily for navigation, were thus used for drainage purposes. In times of flood considerable trouble was experienced in the evacuation of drainage water from the occupied area, and in maintaining traffic on the canals. The Furnes-Dunkirk Canal, however, could be kept at its normal level by closing the Nieuport lock at Furnes, whereby it could be isolated from the other two and navigation along it, which was always particularly active, maintained. To insure the complete drainage of the land it was essential that all ditches should be kept free of obstruction. For this purpose a "special service of waterings" was entrusted to the *génie*. Its duty was to watch the currents and to dry up the land. A system of gauges at all critical points was established. In spite of all precautions, the army suffered cruelly from the continual struggle against the waters.

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In November, 1914, after the capture of Dixmude by the Germans and the retreat of the 89th French Territorial Division on the left bank of the Yser and the Ypern e Canal, it was decided to inundate the land south of Dixmude as far as Knocke. The left bank of the Yser is embanked south of Dixmude, whilst the right bank is low from *borne* 21·5 southwards, and this admitted of all ground to the east of that part of the Yser being flooded by the admission of sea water. The limits of this inundation were, therefore: the right bank from Dixmude to *borne* 21·5, thence the left bank as far as Knocke, the Knocke dam and the road Knocke-Driegrachten up to a point at level 4·30. The Knocke dam, consisting of sandbags laid between the piers and abutments of the bridge, was constructed by the French Army. This inundation was regulated by the Ypres lock and its weir; it was called the inundation of Blankaart, after a pond in that area. It was kept at level 4·00 so as not to flood the trenches in the bridgehead immediately south of Dixmude. But the waters of the Yser equally affected the Handzaeme Canal, which overflowed and caused a further inundation north of the town.

The construction of the Knocke dam left no outlet for the upper waters

of the Yser. The overflow was evacuated by the weir of Fintelle, the canals of Loo and Furnes-Nieuport, and the Furnes lock and weir, and, after the destruction of the latter, by the Oostvaart lock and the Noordvaart. But in heavy floods the Dunkirk Canal had to be used as well, and navigation on all the canals had to be stopped.

In order to make the inundation of Blankaart independent of the Ypres lock, the destruction of which would have left the ground south of Dixmude at the mercy of the tides, a sandbag weir with its lip at level 4·00, was constructed at *borne* 21·500.

* * * * *

At the beginning of 1915, the French Army considered it necessary to make an inundation upstream of Knocke. An attempt was made to introduce sea water through the Furnes lock and by the canals of Nieuport-Furnes and Loo, but the result was not satisfactory.

Pumps were, therefore, installed at Fintelle for pumping water from the Loo Canal; normally this was not necessary, as a flooded area could be formed by stopping the evacuation of surplus water from the upper Yser. But in summer, owing to the loss of water through evaporation, pumping was always required. This inundation, the desirable level of which was fixed at 4·30, was most capricious, there was always too much water in winter and not enough in summer.

* * * * *

These two inundated areas above Dixmude were very interesting, not only because they protected an important part of the front, but because they acted as a reserve for the inundation of Noordvaart. In May, 1915, a breach was made in the left bank of the Yser at *borne* 15·700 in order to connect the Yser with that area, so that the waters of the two upper inundations, the levels of which were 4·30 and 4·00, could be utilized to supplement the lower one, the level of which was 3·20.

* * * * *

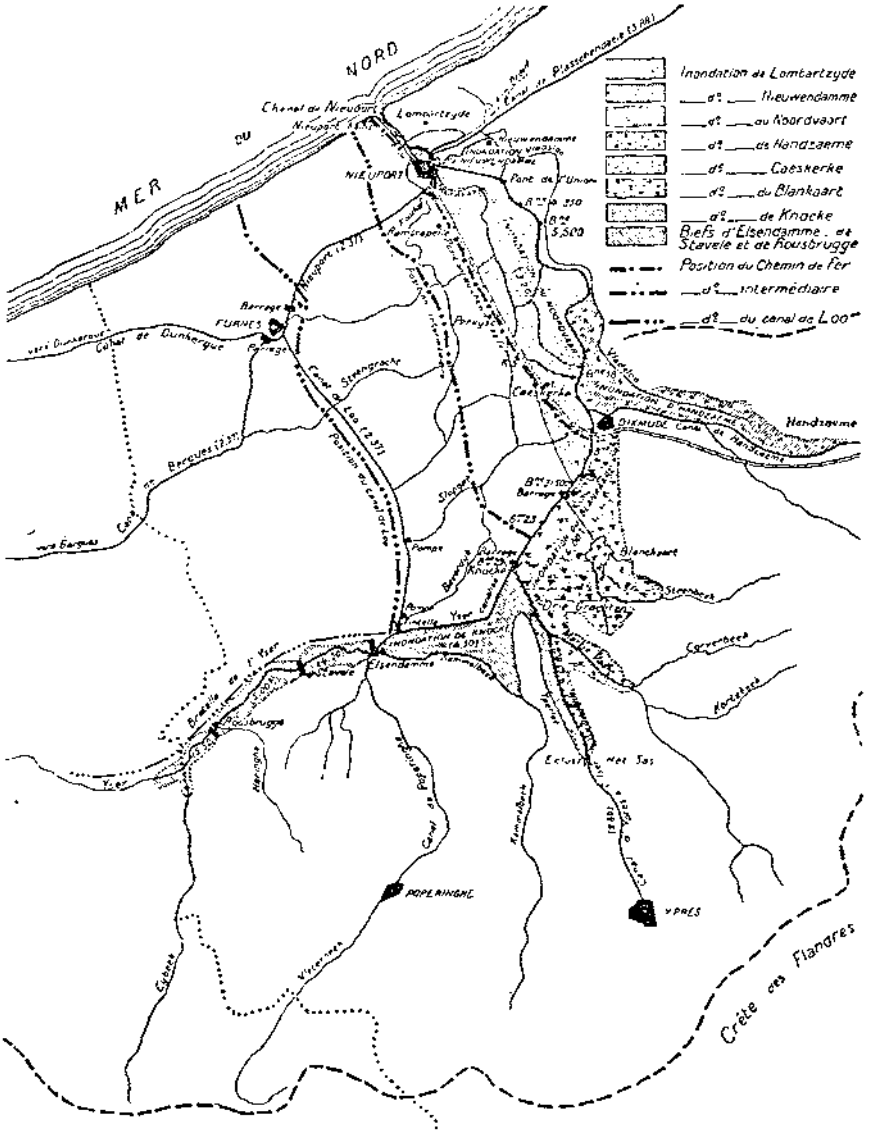
When Lombartzyde was reoccupied by the French, who were defending Nieuport at that time, various measures were taken by them. The creek of Nieuwendamme, which was entirely inundated, was drained at low tide by means of the weir of the Old Yser. Then, to protect the trenches made by them in that area, they made a breach in the north bank of the Yser and effected an inundation through the weir of the Ypres lock. This they called the "inundation of the Polder." Owing to the existence of the bridgehead, it was impossible to use the Nieuw-Bedelf Canal for obtaining sea-water, as the whole area of the bridgehead would have been submerged.

By preventing the evacuation of water from the ground in German occupation, that area would become automatically inundated. To this end, the French troops constructed a sandbag barrage at the Nieuw-Bedelf bridge, called the "pont de Pierre," thereby causing an inundation called "Groot Bamburg." This was increased by draining sea-water from the Plasschendaele Canal through a breach made upstream of the bridge in the north bank of the Canal, water being admitted at every high tide by the lock "du Comte" at the end of the canal. The Germans retaliated by opening a connecting lock between the Plasschendaele Canal, and a branch of the Old Yser, sending back into the Old Yser and the French trenches water intended for themselves. It was,

therefore, necessary at every low tide to evacuate by the weir on the Old Yser a large part of the water admitted at high tide into the Plasschendaele Canal. This plan was soon abandoned.

In May, 1917, the French troops were relieved by British, who had

Revue du Génie militaire Tome LXIII Inondations de la région de l'Yser en 1918



Major Deguent, Les Inondations du Front belge 1914–18.

difficulty in preserving the bridgehead. German artillery destroyed the weir of Nieuw-Bedelf, and the sluices of the lock " du Comte," which left the whole area of the bridgehead at the mercy of the tides. Attempts were made during two months to repair the damage, but without success. This is a rare example of an inundation caused by gunfire.

In 1918, the Belgians again took over the Nieuport sector. The general defensive imposed on the Allies during the first six months of the year led to the extension of the area of inundation north of Nieuport. Breaches were made in the north bank of the Channel of Nieuport and in the Lombartzyde road to allow sea water to cover the whole of that area.

* * * * *

Up to 1917 the Germans had retaliated by artillery fire, often of great violence, to these hydraulic operations, but as far as is known they did not undertake any special works to oppose them. But in October, 1917, aerial photos revealed the construction of a German barrage across the Yser at *borne* 4·350, the object of which was evidently to prevent all evacuation through the Ypres lock so as to insure a defensive front between Dixmude and Ypres. This barrier was destroyed by gunfire.

In January, 1918, a new barrier was observed at *borne* 5·500 on the Yser Canal, but this time artillery fire had no effect. It was not long before unpleasant results became evident. Owing to torrential rains in the early months of 1918 the inundation above Knocke reached the level 4·80; water overflowing into the Yser, and, stopped by the German barrier, swelled the inundation of Noordvaart through the breaches in the bank of the Yser and by sluices which were in German hands, so that it reached the level of 3·70 (normal 3·20). The situation in all the flooded areas became extremely critical. The railway embankment had been weakened by numerous dug-outs, and mined by rodents, dangerous leakages and fissures had occurred, and a general rupture was feared. Reinforcing works were immediately undertaken, but the army was threatened by a catastrophe of the most serious kind. It was then that the plan was conceived of evacuating as large a quantity of water as possible through the locks at Dunkirk. Water was taken there along the Loo and Dunkirk Canals: the powerful pumps of the Loo Canal and at the Fintelle lock worked day and night; all navigation was stopped. In spite of these efforts, disaster could hardly have been averted had not the rains suddenly stopped.

The experience of Riga had shown that an inundation was not an infallible obstacle, and it was decided to make a further inundation west of Dixmude, to be called the inundation of Caeskerke, extending from kilo 5 on the railway to *borne* 19 on the Yser Canal. The defensive line consisting of a continuous breastwork, formed the dike along its western side. It was further arranged that the inundation should, if necessary, be extended westwards in a series of zones between the first line of defence and the Loo Canal.

Since 1915, the possibility of flooding all the land east of the Loo Canal by means of water from Dunkirk had been considered, in case the Belgian Army should be forced to retire on that line, for water from the inundation of Noordvaart would not have sufficed for that purpose. To enfurther this scheme two dams were constructed:

(1) Across the Furnes-Nieuport Canal near Furnes to prevent waters sent from Dunkirk being evacuated at Nieuport by the enemy.
(2) Across the Bergues Canal near Furnes to prevent the area occupied by the Army being submerged.

Each dam had a navigable by-pass. These works were satisfactorily completed during the first six months of 1918.

Water sent from Dunkirk at high tides by the Dunkirk and Loo Canals could be spilt through the locks of the principal canals of the Furnes *watering*: Steengracht, Slopgat, Beverdyck and finally by breaches to be made in the eastern bank. But in order to insure the availability of Dunkirk water, even at low tides, the English Army installed there a battery of six pumps under concrete protection.

At the same time, in order to strengthen the position along the Upper Yser, dams with weirs were constructed across it at the bridges of Elsendamme, Stavele and Rousbrugge, whereby three inundated areas were formed at levels 4·50, 5·00 and 5·50. A serious obstacle was thus created, which, however, was never required to play a part in the defence.

A dike was also constructed north of the Furnes-Dunkirk Canal to safeguard the Furnes-Dunkirk railway and the littoral region; this dike was later on raised and extended into French territory.

* * * * *

The rest of the article contains an account of the principal injuries done to the hydraulic works, and the measures taken to counteract them, and of the means taken to reduce the inundations for the offensives of 1917 and 1918.

The *October* number contains an article by Colonel Sergent on the work of the 26/2 Company of Génie at Mahédia, at the mouth of the Wadi Sebou, in Morocco, in May, 1911. This place, which had been occupied for a few months in 1515 by the Portuguese, and from 1614 to 1681 by the Spaniards, was selected as a secondary supply base. The first job given to the company commander was to provide an adequate water supply, as there was only one well in the place. The prospect of finding water appeared to him hopeless till he recollected certain encouraging principles of Paramelle contained in his book, *The Art of Discovering Springs*, which is widely used in Algeria. A well was accordingly dug at the foot of a small ravine in which water was found at a depth of 2½ metres. In a few days a dozen wells were dug, showing that a subterranean surface of water had been struck. The existence of this supply appears to be in accordance with the instruction given at the Ecole Militaire du Génie to the effect that: "in a massif bounded on one side by the sea and on the other by a river, there often exists a sheet of water above the level of the sea and the river, and inclined towards both. The exploitation of such water-bearing strata has been successfully carried out in Belgium and Holland. In our colonial possessions of Senegal, the towns of Dakar and Rufisque have been so supplied, the latter by means of wells and the former by galleries."

The November number contains an article by Chef de bataillon J. L. R. Faure on the construction of the railway connecting Thiès near Dakar in Senegal to Kayes on the Senegal River in French Soudan, a distance of 667 kilos.

An article entitled "Inundations in Orania," by Chef de bataillon Mauboussin, describes the repairs carried out by the sappers in Algeria following on the damage caused by the heavy rains in November and December, 1927, and January, 1928. The areas which suffered were the

region Orléansville-Tenès traversed by the Wadi Allala, the region Mostaganem in the valley of the Wadi Ain Sefra, and in the region drained by the Wadi Saida and its tributaries, which reach the sea at La Macta. Roads, bridges, pipe lines and embankments were swept away, and a large reservoir was breached.

A.H.B.

REVUE MILITAIRE FRANÇAISE.

(*October*, 1928.)—Commandant d'Argenlieu finished "*La bataille de l'Avre*" in this number. The instalment gives first a short description of the action of the German troops, and then draws certain conclusions. The writer admits frankly that the German troops, trained in Russia, ran rings round the French at first, but he points out how quickly the French took to the new open warfare, and how their final success was reflected in letters captured from prisoners. The conclusions are familiar to us: the will to win, as exemplified particularly by General Débéney, and the problem of organization of staffs during the confusion of units always produced in defensive operations of this sort.

The fourth instalment of Colonel Bailly' "*Franchissement des fleuves en présence de l'ennemi*" appears in this number. The Austro-German attempt to cross the Piave in June, 1918, is the example selected, and a detailed description of the preparatory measures is given. The extreme difficulties of the operation are clearly pointed out, and a good bird's-eye view of the Montello, on the front of attack, illustrates the instalment.

"*Le général Brialmont*," by Lieutenant-Colonel Mayer, is really a review of the biography of Brialmont, the designer of the fortress of Antwerp. Brialmont died in 1908, and his niece has brought out this excellent little biography. The General was evidently a better engineer than strategist, but his views on the design of fortresses were eminently sound. He was brought up to use the gun and fishing rod, rather than the pen; but once he began to study for the Army he combined writing with his military duties from the start. He was a great opponent of the idea of a large number of small fortresses, which held the field seventy years ago, and he was really responsible for introducing the defended camp, such as was Antwerp at the outbreak of the Great War.

In continuing "*De L'ancien au nouveau règlement du Service de Santé*," Médecin Général Uzac describes the different medical echelons from front to rear, with illustrations from different operations of the Great War and the War in Morocco. The most interesting example given was the evacuation of wounded from advanced landing grounds in Morocco by aeroplane. There is no doubt that aircraft will become of more and more importance for this work in uncivilized countries.

"*L'opération effectuée sur Bou-Ganous le 25 septembre 1925*," by Colonel Gondot, describes a minor operation carried out with complete success in Morocco. The reasons for the success were mainly detailed reconnaissance, both by air and on the ground, the provision of troops solely for mopping up, and the actual energy and drive of the troops employed. Although four sketches are given, the detail on them is insufficient, and the article is written in a rather dull form; but as an example of a minor operation of this kind it is well worth studying.

(*November*, 1928).—"*Comment mettre sur pied une monographie de combat*," by Colonel Grasset, is an interesting little article by this well-known French military writer. Three main questions are considered: the writer, his materials, and the time available. Colonel Grasset points out how difficult it is for a writer to guard against bias; he then discusses the various orders, reports and *questionnaires* from which the article must be drawn up, and finally he points out what a long time is necessary before the writer can be finally sure that his monograph is really correct. Colonel Grasset's well-known books on Ethe, Virton, etc., took from five years upwards to complete, and there is no doubt that he was successful in "delivering the goods" in these monographs. This article is of real value to anyone who proposes to write monographs of this type.

In the third instalment of Médecin Général Uzac's "*De L'ancien au nouveau règlement du Service de Santé*," some of the lessons of 1918 are discussed. The writer points out that, although the present French organization is based on the experiences of this particular year, it must be realized that the next war will probably be a war of areas, rather than lines, and consequently highly mobile ambulance formations may be required. The inefficiency of the French ambulance trains, compared to ours and the Americans', during the Great War, is alluded to; and the writer points with approval to the new system of earmarking possible hospitals in various regions in the event of war.

"*L'ajustage des feux et la manœuvre*," by Général de St. Maurice, is a discussion of the axiom that an advance is carried out by fire and movement. The tendency during the Great War was for the infantry to walk forward protected by an overwhelming artillery fire, but the writer points out that the infantry should also do its part. Artillery fire is bound to be partially blind, and the infantry should normally be in a position to fill in the gaps in the fire of the artillery. This instalment is rather spoilt by being written in a form which does not make the salient points very clear, and there is a superabundance of italics.

Commandant Oudet, in "*Sur les méthodes d'étude des nouveaux matériels de guerre*," discusses the disappearance of the old régime, when most war material was made in State arsenals, and gives his views as to requirements for the future. Invention is now progressing at such a pace that it is useless to turn out a vast number of (say) tanks now, as they will probably be obsolete when war comes. A sharp division is therefore necessary between experimental and mass construction. While State factories will continue experimental work, it will probably, in the future, be the duty of private firms to undertake general construction. The article is an interesting discussion of what is really the mobilization of industry for the next Great War.

Colonel Bailly completes "*Franchissement des fleuves en présence de l'ennemi. La bataille de Montello.*" He describes briefly the passage of the Piave by the Austrians and their retreat a few days later. The technical reasons for the failure were the lack of training of the Austrian engineers and the failure to provide a sufficient reserve, but it must be realized that the front of the attempt to cross was too narrow, so that Italian guns were able to converge on the short successful crossing, and so prevent a further advance. The flanks of an effort of this kind

are bound to be the most vulnerable part of the movement, and so a tremendous artillery and air superiority is required by the attackers. The writer concludes by pointing out that the percentage of successes in river crossings has decreased considerably during the Great War, and he asks for the further training necessary to establish the confidence required between the engineers and the attacking troops.

(*December*, 1928.)—Capitaine Minart begins "*La division Exelmans le 28 août 1928*" in this number. General de Laurezac's V Army was retreating, and he had already fallen out with the British Commander-in-Chief. Apparently General Exelmans, in the centre of the V Army, received a report that the IV Army was engaged in a decisive struggle on the Meuse, and also that part of the German forces had veered off to the west. This induced him to turn on them. This instalment describes the arrival of the leading German troops in Guise, on the front of the V Army.

Général de St. Maurice completes "*L'ajustage des feux de la manœuvre*" He begins by an example from his own division, the 37th African, which took part in the great attack of 8th August, 1918. Here he shows how, after a successful attack, the lack of a mobile machine-gun unit prevented the utter rout of the enemy, and again, how the enemy were allowed to re-form because the infantry were awaiting artillery fire instead of carrying on with their own weapons. The article is concluded by the forecast of small tanks, or similar vehicles, for battalion and regimental commanders, so that they can get about more easily to co-ordinate the fire of the infantry, and also by the opinion that more wireless will be required to improve the liaison between the infantry and the artillery. This liaison question has always been one of the biggest problems of modern war, and it seems that the designer of wireless instruments for forward use has to improve his sets considerably yet before they can be depended on in the forward area.

Lieutenant Kersnowski's "*Une mise au point*" is a Russian's opinion of the German successes in East Prussia of 1914. While admitting the value of Ludendorff's direction of the different battles, Lieutenant Kersnowski points out how General Hoffman had already prepared plans for the Battle of Tannenberg before Hindenburg and Ludendorff took over command. He also explains that the German claims of prisoners are grossly exaggerated. To us, who have had an impartial account of the battles from Sir Edmund Ironside, the article is not of particular interest.

Capitaine Perré has a sensible article entitled "*La protection des chars dans la bataille*" in this number. He points out that the commanders of tank formations are apt to call for an excess of protection, whereas they are really in the same situation as commanders of other formations until they actually attack. All troops require protection while on the move, but in the attack tanks are specially vulnerable to the anti-tank gun. This is where the infantry becomes particularly valuable. The tank provides protection against the enemy's infantry and machine-guns; the infantry provides protection against the enemy's guns at point blank ranges. It is only by close co-operation between tanks and infantry that both arms can act to their fullest efficiency.

Colonel Grasset begins "*Montdidier, le 8 août, à la 42e division*" in this number. The instalment is devoted to a most graphic description of the preparations for the great attack, and of the special measures taken to camouflage these preparations. The camouflage was so successful that the front line troops had no idea of what was impending, which was just as well owing to a successful German raid before the attack. Colonel Grasset has the knack of making the salient points stand out from a mass of detail, and this instalment gives a very good idea of the enormous amount of work required before a trench warfare attack can be launched.

H.A.J.P.

CORRESPONDENCE.

RAILWAY DEMOLITIONS.

Railway Training Centre, R.E.
Longmoor Camp,
Hants.
5th December, 1928.

The Editor, *The Royal Engineers Journal.*

DEAR SIR,

Referring to Lieut.-Colonel E. P. Anderson's letter in the *R.E. Journal* for December, 1928. It is fully realized that guncotton slabs *under* the rail are more effective than at the side of the rail in track demolitions, and this is advocated at the Railway Training Centre, R.E. Vertical cutting was forbidden in this case, however, because of the risk of casualties from flying pieces of rail to the raiders themselves, and to a thickly populated camp near by. Horizontal cutting was, therefore, arranged, so that all pieces flew horizontally away from the Camp, and away from the raiders themselves. This fact should perhaps have been made clearer in the article.

The rail and bridge demolition was described as actually carried out. At a later date, other pile and trestle legs (soft wood) were destroyed by auger holes filled with primers, necklaces, and guncotton slabs in various arrangements and quantities. As stated by Colonel Anderson, five or six primers in an auger hole was certainly the most effective method of all. The 12 x 12 timber was split longitudinally for some five to six feet each side of the actual cut, and set on fire in two cases. The bridge gap was, of course, a dry one, there was a high wind, and the whole bridge would probably have been gutted as a result of the fires which started in two splintered legs. Necklaces were useless. The five primers applied internally were more effective than three guncotton slabs applied externally.

Yours faithfully,
I. SIMSON, *Major, R.E.*

RATIONAL MECHANICS.

The Editor, *The Royal Engineers Journal.*

SIR,

I have to thank you for the review of my little book, which is certainly very flattering—and (I hope) deserving of it.

The reviewer says some of my criticism is " captious " ; I hope that in this he is mistaken : I tried my best not to attack simply for the sake of attacking ; when necessary, however (having specialized on Hydromechanics for nearly 40 years, and having studied how *real* fluids actually *do move*), I have not been afraid to attack ; and as your reviewer further says, I am " no respecter of persons or theories," meaning by this, that I grovel before no man's *opinion*, though I hope I " respect " those I attack. In fact, if I did not, I would not attack their views. He will, I feel sure, do me the credit of admitting that I never attack any small man. If a writer has arms on his shield, and wears gold spurs, he is a knight worthy to break a lance with.

As to " theories," I have not hesitated to call the almost sacrosanct, Kinetic Theory of Gases (that happy hunting-ground of the mathematicians) a " wild-cat theory " ; since such an imaginary medium *could not vibrate*. The Professor to whom I said this lately, replied that he " saw no reason why it should not vibrate." I, also, see no *reason* why pigs should not fly. I know they do not ; and I think I am justified in saying that no animal built on these lines *could* fly. He would not have *de quoi*.

Your reviewer makes a slip when he says I " endow " liquids and gases with rigidity. I endow them (and solids too) with *viscosity*. Rigidity (as I think the term should be used) is *not a property*. It is nothing more than *the measure of the intensity* of the resistance to change of shape. To speak of rigidity (in the proper *mechanical* sense), without reference to time, is, in my mind, meaningless. The rigidity of water, *in unit time*, is negligible. In one-thousandth of a second it is *very large*. Similarly, the rigidity of ether in 10^{-15} of a second is *colossal*.

My views (right or wrong) were derived from P. G. Tait's *Properties of Matter ;* at page 290, para. 316, he says, " The dimensions of viscosity therefore differ from those of rigidity simply by the time unit ; *i.e.*, as the dimensions of velocity differ from those of acceleration."

This I read as, $\text{Rigidity} = \frac{\text{Viscosity}}{\text{Time}}$. If your reviewer can give me any better and simpler view, I shall be delighted to accept it. It must explain, of course, why one cannot cut a very rapidly flowing jet of water with an axe. How water can dent in the armour-plates of a battleship. How a rapidly rotating closed chain can hop along the floor like the wheel of a bicycle, etc., etc.

To call this " pseudo-rigidity " *means* nothing. As well call it " pure cussedness."

That the reviewer was disappointed with my chapter on " relativity " was unavoidable. I know nothing of metaphysics ; nor can I understand a theory of " relativity " which is *based on an absolute*—whatever " absolute " may mean. I consider Einstein's theory a very beautiful

mathematical fairy tale, told in very beautiful (as far as I can follow it) mathematical poetry. I should call it (with apologies to Dante) "the mathematical comedy." My views on it might be expressed by a quotation from Epictetus.

'If you will consider this with me, I shall say, first, that you must attend to the sense of words.

"—— so, I do not understand them?"

You do not.

"—— How then, do I use them?"

As the unlettered use written words, or as cattle use appearances; for the use is one thing, and understanding another.'

R. DE VILLAMIL.

December 12th, 1928.

MOTHER SHIPTON'S PROPHECY.

IT may be of interest to read the words of an old English wise woman, uttered about 1530 near Knaresborough, Yorks, and to notice what parts have come true, and the possibility, or otherwise, attached to those which have not yet been obviously verified.

Over a wild and stormy sea
Shall a noble* sail,
Who to find, will not fail,
A new and fair countree,
From whence he shall bring
A herbe† and a root‡
That all men shall suit,
And please both ploughman and king;
And let them take no more than measure,
Both shall have even pleasure
In the belly and in the brain.
Carriages without horses shall go,
And accidents fill the world with woe.
Primrose Hill in London shall be
And in its centre a Bishop's see.
Around the world thoughts shall fly
In the twinkling of an eye.
Waters shall yet more wonders do,
How strange, yet shall be true,
The world upside down shall be,
And gold found at the root of a tree.
Through hills shall men ride
And no horse or ass be by their side.
Under water shall men walk,
Shall ride, shall sleep and talk;
In the air men shall be seen,
In white, in black and in green.
A great man shall come and go—

* Sir Walter Raleigh. † Tobacco. ‡ Potato.

Three times shall lovely France
Be led to play a bloody dance ;
Before her people shall be free
Three tyrant rulers shall she see,
Three times the people's hope is gone,
Three Rulers in succession see,
Each springing from a different dynasty,
Then shall the worser fight be done
England and France shall be as one.
The British olive next shall twine
In marriage with the German vine.
Men shall walk over rivers and under rivers,
Iron in the water shall float,
As easy as a wooden boat :
Gold shall be found and found,
In a land that's not now known.
Fire and water shall more wonders do.
England shall at last admit a Jew ;
The Jew that was held in scorn
Shall of a Christian be born and born.
A house of glass shall come to pass
In England, but alas !
War will follow with the work,
In the land of the Pagan and Turk,
And State and State in fierce strife
Will seek each other's life.
But when the North shall divide the South
An eagle shall build in the lion's mouth.
Taxes for blood and for war
Shall come to every door.
All England's sons that plough the land
Shall be seen, book in hand.
Learning shall so ebb and flow,
The poor shall most learning know.
Waters shall flow where corn shall grow,
Corn shall grow where waters doth flow.
Houses shall appear in the vales below ;
And covered by hail and snow,
The world then to an end shall come
In Nineteen Hundred and Ninety One.

D.M.F.H.

All communications for the Institution should be addressed to:—
The Secretary, The Institution of Royal Engineers, Chatham.

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Secretary: Lieut.-Col. P. H. Kealy, 1st October, 1927.

2,150—1-3-29.

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Will any officers who have had experience of any of these and can supply useful information, or are prepared to criticize such notes as are available, get into touch with the Officer i/c Training Manuals Revision, Room 037, War Office, Whitehall, London, S.W.1.