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ENGLAND'S FOOD SUPPLY.

A Lecture delivered at the School of Military Engineering, Chatham, on December 3rd, 1931, by C. ERNEST FAYLE, ESQ.

THE food supply of the United Kingdom is a very big and a very complex affair. It includes questions of production, import, finance, marketing, shipment, storage, and distribution, on any of which a specialized expert could talk to you for many hours without exhausting his own branch of the subject. I am not a technical expert in any of these branches; but it has been my business, in writing "Seaborne Trade" and in my work for the various Service Colleges, to try and form some impressions of the problem as a whole, and of the relative importance of the different activities whereby the people of these islands are fed. It is this broad general view which I have been asked to put before you in outline.

The first outstanding fact that emerges when we begin to study the problem is that it is predominantly a problem of foreign trade. I do not want to bother you with a lot of figures, but there are one or two so important that they must be quoted. We import four-fifths of the wheat we consume, over 60 per cent. of the meat (including bacon and hams), 90 per cent. of the sugar, 90 per cent. of the butter, half of the eggs, and three-quarters of the fruit, and of course there is a long list of other articles, such as fish, lard, tomatoes, tea, coffee, and cocoa, some of which we do not produce at all, while of others we import a large proportion of our supplies. Potatoes, green vegetables, fish, milk, and beer, are almost the only items of which the home production substantially exceeds imports.

Taking all items together, reducing them to terms of nutritive value, and making allowance for the fact that our own production of cereals, meat, and dairy produce depends in part upon the import of

fertilizers and fodder, it is safe to say that we depend on imports for at least two-thirds of our annual food supply. The imports amount normally to 18 or 19 million tons, and the lowest point to which they were reduced during the War, when home production was being stimulated, every possible economy enforced, and consumption drastically rationed, was 11½ million tons. Even then it would not have been brought so low if many supplies had not been sent direct to our troops abroad.

Perhaps it gives a better idea of the problem we have to face, if we say that the normal imports coming under the head of "Food, Drink, and Tobacco," are equivalent to at least 3,600 full cargoes of 5,000 tons each, or to the load of 1,800,000 ten-ton trucks or lorries.

I do not propose to spend time in examining the possibility of increasing our home production of food to such an extent as to reduce substantially our dependence on imports. In the first place, I am not an agricultural expert, and the experts differ so widely as to what is possible that they leave the plain man rather sceptical as to the higher estimates. Secondly, I do not think there are many people who really believe that any practicable increase in production would remove the necessity for imports on a very large scale. Finally, my job is to deal with things as they are and not as they might be.

Now I do not want to wander away from my subject into a general disquisition on foreign trade; but there are two points about this dependence on overseas supplies—quite apart from the narrower problem of handling and distributing the imports—which are so important that I cannot pass them over.

In the first place, all this imported food has to be paid for. It is paid for mainly by bills of exchange—"scraps of paper," and our supplies of food would very soon come to an end if these bills were treated as other "scraps of paper" have been in the past. The readiness of the foreign or Dominion food producer to accept bills of exchange in payment depends upon his certainty that he can turn them into cash or credit, and this, again, depends upon the certainty that they can be used in payment for British manufactures, or for services performed by British shipowners, financiers, underwriters and others. We really pay for the food we receive from overseas by the goods which we send abroad, and by the services which people in this country render to people in the Dominions and foreign countries by lending money to them, carrying their goods from port to port, insuring their ships, acting as brokers and agents in their business affairs, and in many other ways.

This is a point which must be kept very clearly in mind in war as well as in peace. We shall be much more cautious about allowing our economic life to be even temporarily dislocated, either by any social upheaval or by excessive military commitments, if we remember that millions of our people must literally starve to death unless our

business men are left free to perform these services, unless our export industries are kept at work, and unless the raw materials for these industries can be freely imported, and paid for by further exports.

The other point I want to make is the vital importance of keeping open as many sources of supply as possible for those foodstuffs which are most essential to us. Prolonged storms, or prolonged drought, strikes, revolution, or war, may render any one source of wheat or meat unable to ship its normal surplus. In that event we shall have to make good the deficiency by increased imports from another source, and you cannot suddenly develop a great trade with a country with which you have not already well-established business relations and steamer services.

I would like to quote just two examples of the way in which the elastic and world-wide character of our trade brought us in safety through the crises of the Great War.

Before the War we had five main sources of wheat supply—North America, Australia, Argentina, India and Russia. From the very beginning of the War the Russian supplies were cut off by the closing of the Dardanelles. Then the Australian harvest failed so completely that Australia could not export a ton of wheat in 1915. We made up for the loss of these sources by increased purchases from Canada and the U.S.A. Then came the great shortage of tonnage brought about by the heavy losses of shipping and the requisitioning of vessels for war service. The result was that, although we purchased 3,000,000 tons of Australian wheat at the end of 1916, we had to leave 2,500,000 tons of it there until after the War, and procure every possible ton from North America, because it was only by concentrating our remaining ships on the shortest routes, where they could make the maximum number of voyages in a year, that they could carry our minimum requirements. In 1918, when the North American harvest itself was only moderate, we had to make greatly increased purchases in Argentina because it was the next nearest source.

In like manner, our shipments of meat from the Plate were greatly increased, and those from Australia and New Zealand diminished during the last two years of the War. The main reason was that ships on the Plate Route could carry normally about two-and-a-half times as much cargo in the course of the year as ships on the Australian Route. A further reason was that the big Australian liners with refrigerated holds were wanted in the Atlantic for American trooping. They were put on to a triangular run. They carried general cargo to the Plate, where they shipped mainly meat and wheat, then went up to New York where they embarked troops, and returned thence to British ports with their mixed load of troops and foodstuffs.

I do not want to pronounce an opinion on any matters of current

political policy—Free Trade or Protection, Import Boards, Quotas, or Imperial Preference; but there are so many factors which may affect the output of an exporting country in time of peace, and govern the distribution of our shipping in time of war, that I am sure it is vitally important, whatever general policy we adopt, to preserve good communications and good business relations with every country from which essential foodstuffs, or other vital imports, may be derived.

It is of great assistance to us, in this matter of freedom to draw supplies from alternative sources, that so many of our ships are tramps or general traders, which are not, like the liners, tied to a particular route or a particular home port, but are let out by the voyage, or for a fixed period, to carry goods between any ports the charterer may select.

This is also very helpful in adjusting the distribution of imports. A man may charter a ship on the Baltic Exchange to lift 5,000 tons of wheat at the Plate and carry it to the United Kingdom or any port on the Continent within certain named limits. He can then, while the ship is making her way up the South Atlantic, sell the cargo (also on the Baltic Exchange) to a merchant or miller in any district where wheat is needed at the moment; after which he will send out instructions to the Master, by wireless, or by cable to a port where the ship is calling for bunkers, as to the exact port at which delivery is to be made. A tramp, with a full homogeneous cargo can always be diverted to the port where it is most convenient to take delivery. A liner with a regular schedule of sailings to maintain, and a big mixed cargo of all kinds of goods, consigned to hundreds of consignees at her home port, cannot be diverted in this way without great dislocation, and in the later stages of the Great War, when the bulk of our tramp tonnage was on naval, military, or allied service, great difficulty was often found in supplying grain to those districts in which no big liner port was situated.

The Baltic Exchange, in St. Mary Axe, is the world's chief market, both for the chartering of tramp shipping and for the purchase of full cargoes of grain and similar commodities. The Liverpool Corn Exchange is the chief British centre for the buying of "futures"—wheat not perhaps yet reaped, but to be delivered at a later date. There is, of course, a very strong element of speculation in this business; but in the opinion of those best qualified to judge, its effect is to keep the flow of supplies more even, and also to keep the ultimate price to the consumer more level, than if all transactions were confined to "spot" purchases for immediate delivery.

We have, I am afraid, no time to discuss the finance, insurance, and stowage of food cargoes; but I want, in passing, to emphasize the fact that these are important and highly technical matters. On good stowage, in particular, depends not only the safety of the ship and the preservation of the cargo from damage, but the amount she

can carry. If it should be considered necessary in time of war for Government Departments or Controllers to take over the import of foodstuffs, it is, at least, extremely important that they should make as much use as possible of the skill and experience of people who make their living by understanding these matters.

In view of the very strong feeling that has arisen against making foodstuffs contraband, it is very likely that, if war should break out, the shelter of a neutral flag would be sought for a proportion of our food imports; but these imports are so big, and the British mercantile marine is so much larger than any other, that we should still have to rely very largely on the protection of food cargoes in British ships, and one of the most important items would have to remain almost entirely under the British flag. Refrigerated cargoes, such as frozen meat, can only be carried in ships specially fitted for the purpose, and by far the greater number of vessels fitted with insulated holds are British ships.

We must now, however, leave the question of purchase and shipment, and come to the reception and distribution of the cargoes in this country. The problem of our food supplies, especially in time of war, would be very much simplified if it did not matter much what port a ship reached, so long as she brought up safely in some British harbour. Unfortunately that is most emphatically not the fact. You might almost as well leave a cargo on the other side of the Atlantic as bring it to a port which is not equipped to deal with cargoes of that particular class.

Cargoes of frozen meat and other refrigerated products, such as dairy produce and many kinds of fruit, cannot just be dumped on the quays. They can only be unloaded at ports where there is cold storage for their reception. More than 90 per cent. of the refrigerated meat landed in this country is actually discharged either at London or Liverpool, and if these two ports were put out of action, we might as well stop at least two-thirds of the sailings of meat ships for the United Kingdom, for the cold storage available at the other ports would not be sufficient to deal with them. The reason for this concentration of trade is obvious. The Port of London feeds the thickest concentration of population in the country. Liverpool distributes frozen meat to the crowded industrial centres of the North. If either of these areas had to be supplied through ports at a greater distance, it would entail, among other things, a greatly increased provision of insulated vans on the railways.

Then again, to discharge quickly large cargoes of grain in bulk we need silos and elevators which are useless for any other purpose, but are indispensable for this particular job; and the quantity of grain a port is capable of handling depends on its equipment in this respect. It is an advantage also that wheat should be discharged at a port where big flourmills are situated. Otherwise unnecessary rail

haulage is incurred between the port and the flourmills, and the flourmills and the centres of consumption. Moreover it is easier to distribute the grain cargoes from the port in the form of flour, as the flour takes up 30 per cent. less space than the wheat; that is to say, it requires 30 per cent. fewer trucks to distribute it.

Imports of wheat and flour are rather more evenly distributed than those of meat, but about one-third of the imports are received by the Mersey ports, Liverpool and Manchester, and about one-quarter by London. The only other port which takes more than one-tenth of the whole is Hull, with 14 per cent. And I would again emphasize the fact that it is useless, in time of emergency, to send grain ships to ports which are not used to handling grain in large quantities, and are not equipped for doing so. For instance, even big ports, like Cardiff and Newcastle, which specialize in the export of coal and the import of iron ore and pit props and are mainly equipped for that purpose, import only so much wheat as will satisfy local requirements, and if they were suddenly called upon to take care of a substantial proportion of the supplies needed in London, they would be physically incapable of either receiving or distributing it.

You will see that the equipment of the ports is, to a great extent, specialized. They differ also in the areas which they serve. The Port of London, for instance, has been created to serve the needs of the dense population of Greater London, which is crowded into a comparatively small area. A large proportion of the imports go direct or almost direct from the docks to the markets, or overside into barges and lighters which carry them to the long succession of warehouses and flourmills stretching all along the banks of the Thames from Tilbury to Teddington. Very large warehouses, cold storage sheds, and flourmills surround the docks themselves. From all these, food imports can be distributed to the wholesalers and traders, as and when required, by rail, canal, cart, or lorry. Liverpool, on the other hand, is what is known as a "through transit" port. It serves not only local needs but the needs of dozens of big industrial towns spread over a wide area. It has big warehouses, but the whole trade of the port is so organized that imports may be rushed through as quickly as possible to inland storage centres from whence they can be distributed to the consumers. Hull is perhaps still more emphatically a "through transit port." Its trade is many times greater than the needs of the local population, and its strength lies not in the extent of its warehouse accommodation, but in the excellence of its communications, which enable it to distribute imported cargoes over a very wide area in the North and Midlands.

You will see at once how this bears on the problem of our food supplies. However big the warehouse accommodation at a port may be, it is no good sending to that port cargoes intended for distant inland centres unless the roads, railways, and canals that

serve it, and the general organization of the port itself, are well adapted for distributing cargoes over a wide area. Other things being equal, the port nearest to the consuming centre is always to be preferred, because every extra mile that has to be covered adds to the number of trucks, lorries, or barges that must be employed.

This question of facilities for distribution is at least as important as that of port equipment. Unless goods are quickly removed from the quays to the warehouses, ships arriving to unload new cargoes will find no space at which they can discharge. Unless goods are sent on regularly and promptly from the warehouses to the consumers, the storage space will soon overflow and the quays become choked. And when once congestion has set in, every ship directed to the port makes things worse. The ports have very truly been termed the bottle-neck of foreign trade, and as you very well know, when traffic becomes jammed in a bottle-neck, the state of things will get steadily worse and worse unless the flow of traffic is stopped until the jam has been cleared.

It was very difficult to make the importing departments realize this during the War. The Sugar Commission, for instance, were laudably zealous in buying sugar and arranging for its shipment, but they had an inexplicable dislike to bringing the cargoes forward from the ports to inland storage, with the result that thousands of tons of sugar, left in the warehouses at the ports, were continually blocking the discharge of everything else, and assisting to intensify the port congestion which led to such deplorable delays to shipping, and so reduced our importing power. The various authorities controlling wheat imports were zealous in the work ; but they often caused grave congestion by trying to force through the ports more than they could distribute at the time. But perhaps the most striking single illustration was the great bacon glut of 1918. In that year the Ministry of Food purchased, for delivery at West Coast ports only during about four months, more bacon than was normally imported at all ports during a year, and they gave the port authorities very short notice of the arrivals. To make things worse, bacon was a rationed food, and the Ministry were so afraid of letting it out of their control that they liked to store it at the ports and peddle it in small quantities to the retailers. The natural results followed : the ports became choked, the discharge of other imports of food, munitions, and materials was impeded, ships were delayed, much of the bacon went bad, and more would have done so but for a providential spell of cold weather. Finally, drastic Cabinet action became necessary to clear the jam and prevent a repetition of the same kind of thing.

This necessity of preserving a free flow of traffic through the ports is made immensely more important by the fact that it is useless, as we have seen, to divert the trade of a congested port to any other port which is not equipped to handle the same class of traffic, to handle

it in large quantities, and to distribute it over a wide area. Let me repeat that London and Liverpool handle over three-quarters of the meat imports and that nearly three-quarters of the wheat and flour imports enter the Thames, Mersey or Humber. There are few other ports whose general food imports are of more than local importance, though there are some that have very useful special functions, such as Bristol in the import of West Indian fruit, and some East Coast ports, such as Grimsby, in handling bacon and dairy produce from the Continent.

Our gravest problem is, of course, that of feeding the population of Greater London if, for any reason, the working of the Port of London itself should be interrupted. It can be done for a week or two, as in the General Strike and the last great Dockers' strike, by drawing on the stocks in hand, supplemented by such help as other ports can give, but the limit is soon reached, and would be still sooner reached if it were necessary (as it would be in the event of any prolonged interruption) to maintain also the supply of raw materials to the innumerable factories of the Greater London area, and the distribution of their products.

The difficulty of transferring any large proportion of London's food imports is immensely increased by the fact that the bulk of the storage accommodation and the majority of the flourmills are situated within the dock area and along the river, and the whole organization of food supplies is based on distribution in detail from the river, the centre of the circle, to the circumference, and cannot be readily adapted to the distribution of supplies received in bulk *on* the circumference.

It would not be possible, in a talk like this, to discuss in detail the technical problems relating to the diversion of London's food supply, even if I were more competent to do so; but I think it can be said without much fear of contradiction that a complete closing of the Port of London would in a short time doom hundreds of thousands of people to sheer starvation, and that any great reduction in its importing capacity would be a grave danger. Should it become desirable to reduce the traffic entering the Thames, then the best port to which ships, especially grain ships, can be directed is probably Hull, where there are large flourmills, and which is particularly well equipped and organized for the supply of consuming centres at a distance. The chief relief channels for meat supplies would probably be Liverpool, Southampton, and possibly Bristol, all of which have probably greater cold storage accommodation than their normal trade requires.

I have spoken mainly of wheat and meat, but I want to impress on you that a wide variety as well as a very large volume of foodstuffs is necessary in order to keep our people at their full health and energy. I do not pretend to be able to talk learnedly about pro-

teins and carbohydrates, but any doctor will tell you how important it is to secure a well-balanced diet in which the bone-forming, and energy-producing, and heat-giving and blood-purifying foods shall all be represented. I would add that it is not at all easy to define "essential" foodstuffs, as what people habitually consume becomes morally and even physically essential to them. The "economic man" of the text-books could get along perfectly well without tea, or coffee, or tobacco; but if the supply of tea and tobacco to the British soldier and the British working class had been cut off during the Great War, it would have made a lot of difference.

There is this, too, to consider—and it is a point which seriously aggravates the dangers of a food shortage and the difficulty of effective rationing—that it is very little use giving people foodstuffs which they have not the necessary knowledge, appliances, and time to cook. It was very much easier for the middle-class housekeeper, when the meat rations were cut down, to make up the deficiency with all sorts of vegetarian dishes, than for a harassed working-class mother, with a day's charing to do, half a dozen children clamouring for attention, and a *batterie de cuisine* confined to a saucepan and a frying-pan. That is not a point which figures in histories of the food control but it was a very real and practical trouble.

Nevertheless, the question of alternative foodstuffs is an important one in time of war, because it is only a part of our food supplies that comes to us in whole cargoes or in specially constructed vessels, and many useful, if not normally "essential" articles of diet can be picked up at ports which do not ship grain, or meat, or sugar, but which do send us raw materials we require for the purpose of the war itself. Hundreds of thousands of oranges, for instance, came to us during the War, in ships that were bringing iron ore from Spain for the munition factories. Again, concentrated foodstuffs, such as nut-chocolate, are a highly desirable form of import when tonnage is short. There are conceivable circumstances in which "Eat more nuts" would be a very patriotic slogan.

You see I am talking again of ship-space, and when we turn to our own home-produced food supplies, transport is still, perhaps, the outstanding problem. Those who are engaged in the production of food can live, to a great extent, on their own produce; but for that larger part of the population which is herded together in great towns, the availability of home-produced, as well as of imported supplies, depends on transport. It is no use, for instance, saying "Eat more fish," unless the fish can be brought to the big centres of population while it is still fresh, and this is largely a question of the provision of special rolling stock. London's fish supply, amounting to some 4,000 tons a week, is practically all rail-borne. Again, the difficulty of marketing British fruit and eggs at profitable prices is very largely a question of the transport charges on small consignments, and the

best hope of its solution seems to lie in co-operative marketing, whereby groups of producers can combine to take advantage of the facilities created by the great development of road-transport. This problem has already been solved in the milk traffic—another traffic requiring the employment of special rolling stock or vans.

The annual consumption of milk, excluding milk used for the making of butter or cheese, is probably between four and five million tons. The annual consumption of potatoes, excluding potatoes fed to animals, is about four millions. To these, of course, you have to add the proportion of wheat, meat, butter, cheese, and fruit that is home-produced, together with fish and green vegetables, of which only a small proportion is imported. You must add also, in estimating the quantity of stuff to be shifted, brewing and distilling materials, and feeding stuffs for live-stock so far as they are not consumed in the areas where they are produced. Before the War the total of home-produced foodstuffs for human consumption was put at well over 13 million tons. I mention this because I want to point out that any violent dislocation of traffic, such as the diversion of imported foodstuffs from one port to another, will cut across this movement of home products, as well as across the normal lines of supply from the ports, and all the vast traffic in fuel, raw materials, and manufactured goods, whether imported or home-produced. Dislocation of imports will impede also the distribution of internal supplies.

I may seem to have harped too much on this question of transport; but it really does seem to me the crux of the problem. It is no good having large food supplies in sight unless they can be brought promptly and regularly to those who need them; and that is not such a simple matter as was supposed by the people who wished, during the War, to feed London through the West Coast ports. I remember one occasion when ships carrying 17,000 tons of grain for London were diverted to Plymouth. Only 7,000 tons of that grain ever reached London, for the movement of that 7,000 tons, cutting right across the heavy military and munitions traffic from north to south, caused such an appalling railway jam, that it was decided to give up the idea of shifting the remainder. I am quite ready to admit that, since the War, the immense development of road transport has greatly facilitated the distribution of supplies, and, therefore, the diversion of traffic; but only within fairly definite limits.

I have been able to give you only a very broad outline of an immense subject, and have not been able to deal in much detail with any of its phases; but I have said enough, I hope, to illustrate its complexity and the care with which it needs to be handled if there is any interference with the normal processes of trade. Before I sit down, may I summarize, very briefly, what seem to me to be the outstanding factors in the problem.

Of the food supplies of Great Britain about two-thirds are imported. The imports are very varied, as is necessary to keep the population in health, and very large in volume, amounting to 18 or 19 million tons. These imports have to be paid for by exports of British products or by services rendered to people living overseas. The problem of maintaining food supplies is thus inextricably bound up with the maintenance of British industries, finance, and shipping, and the preservation of British credit.

Inasmuch as the supplies available from a particular source may be cut off or reduced by harvest failures, or by political conditions, or by the circumstances of war, it is essential to cultivate business relations with a wide range of sources.

Supplies are procured by means of a complex and delicate machinery of exchange, transport, and distribution, which must be kept working smoothly if a breakdown is to be avoided. The smooth working of this machine depends, above all, on the ability of the ports to distribute newly-arrived cargoes quickly and regularly to the areas where they are to be consumed. For this, it is essential that cargoes of imported foodstuffs should be brought only to ports equipped for dealing with cargoes of that particular kind; that the volume of traffic directed to a port should not be greater than it can receive and distribute, and that foodstuffs should be directed, as far as possible, to ports in or near the consuming area.

The diversion of food cargoes, on a large scale, from one port to another, is therefore a matter of great difficulty. In particular, it is probably impossible to feed the population of Greater London, unless the Port of London itself can be kept open.

The availability of home-produced food supplies is also a question of transport, as the main producing and consuming areas do not correspond. Any serious dislocation in the distribution of imports is apt also to impede the distribution of internal supplies.

It all really boils down to this: "England's Food Supply" is not, strictly, a separable problem; but it is an integral part of the greater problem of keeping at work, in all circumstances, the whole economic activities of the country—production, exchange, finance and transport.

DEMOLITIONS CARRIED OUT AT MONS AND DURING THE RETREAT, 1914.

A COMPILATION BY MAJOR-GENERAL SIR REGINALD U. H. BUCKLAND, K.C.M.G., C.B., *Colonel Commandant R.E.*

(*Concluded.*)

29th August (*continued*).

By the evening of the 29th the main body of the II. Corps was south of the Oise, and the Corps diary states that at 1 p.m. orders were sent to the 4th and 5th Divisions to prepare the bridges over the river and canal* for destruction. In II. Corps operation order No. 9 of this date, para. 7 ran as follows :—

"The bridges already prepared for demolition will be blown up by the Engineers responsible for this duty as already detailed, under orders to be given them as follows :—

Bridge at Varesnes, by order of Rearguard Commander, 3rd Division.

Bridges at Pontoise, as soon as the bridge at Varesnes has been blown up.

Bridge at Pont l'Evêque, by order of Rearguard Commander of Division."

The II. Corps also issued the following (time not to be traced) :—

"G. 516. *Instructions as to demolition of bridges.* Two bridges at Pont l'Evêque, two at Pontoise, and two at Varesnes have been prepared for destruction.

"The outpost line for to-night is on the river, with advanced posts of a brigade of infantry at each Crisolles† and Beaurains.†

"The Engineer representative responsible for destruction at each place will place himself in communication with the outpost commander in that locality. If a retirement is ordered, or becomes obligatory, the bridges will be destroyed when the outpost commander has reported that all troops in his neighbourhood are across. It must be clearly understood that at present we are leaving considerable forces of infantry north of the river."

The copy preserved by the O.C. 7th Coy. bears an endorsement by the C.R.E. 4th Div. to the effect that the wording was subse-

* The Oise and the *canal latéral*.

† Three miles N. of Noyon, not shown on the map.

29th August (continued).

quently changed to, " Outpost Commander will place himself in communication with R.E. officers." Evidently the writer of the order had realized, or it had been pointed out to him, that he was placing the R.E. officer in a very difficult position.

The 4th Div.* received on the 29th the following order from the II. Corps (time not recorded) :—

> " Prepare bridges over canal at Sempigny for destruction immediately. Guncotton has been demanded by telegram. Inform us amount required. If you are at present short, Rure† bridge should be prepared in the first instance. Orders as to destruction will be issued later."

Lieut. Macready, with three men of the 7th Coy., was sent to reconnoitre the bridges over the Oise and the *canal latéral* between the Noyon-Pontoise road and Ourscamp, but this company took on only the bridges at Sempigny.

Lieut. Fishbourne, with a section of the 9th Coy., went to Ourscamp to prepare a bridge there (the map shows two), and it was blown up on the same day at the order of the G.O.C. 4th Div. Capt. Westland at 8 p.m. took another section to prepare the bridge at Bailly. This he succeeded in doing, and stood by the bridge all night, but next day Gen. Haldane, 10th Inf. Brig., commanding the rearguard, having been informed by his Divisional H.Q. that the II. Corps wished this bridge to be left intact, ordered him to withdraw his charges. He did so, and rejoined his company on the 31st.

The C.R.E.'s orders for the demolition of the bridges between Pont l'Evêque and Sempigny reached the 7th Coy. at about noon, and work went on all night whilst the 4th Div. was crossing. Lieut. Wright took on the lattice girder bridge which carried the main road over the *canal latéral*, but, as his exploder failed to work, he had instead to use safety fuze, which was successful. Lieut. Macready blew up the bridge over the canal west of the main road, known as the Pont Charlet, and Lieut. Gourlay the stone bridge over the Oise, about 400 yards south of the canal. (App. F.)

All three bridges were ready at 5.30 a.m. on the 30th. Lieut. Macready's was blown up shortly afterwards, and the company marched off, leaving demolition parties on the other two, but, owing to the delays narrated later, these were not destroyed until noon.

The first explosion on the stone bridge damaged it seriously but did not completely wreck it. Whilst a second charge was being

* Div. H.Q., the infantry brigades, and part of the artillery of the 4th Div. had joined the II. Corps at Le Cateau on the 24th August, but the C.R.E. and the Field Companies, who had been railed up independently from Rouen to St. Quentin, and retired thence under orders from G.H.Q., did not join their Division until the 29th at Carlepont. The C.R.E. had distinct orders from G.H.Q. to remain south of the Oise.

† " Rure " should probably be " rear."

29th August (continued).

placed on one of the arches, the cavalry piquet guarding the bridge was attacked by dismounted Uhlans, who had crossed the river in a boat only a few hundred yards from the village, bringing a machine-gun with them. When this opened fire down a small street running through the village parallel to the canal, the horses of the cavalry piquet were taken in enfilade and stampeded, and the R.E. horses took fright and disappeared with the tool cart up a side road into the forest, and were never seen again. The bridge, however, was held until Lieut. Gourlay had fired the second charge, and he got away mounted up behind an officer of the cavalry.

For the sake of clearness of the narrative the order for the destruction of the bridges at Pontoise is best given here, though it belongs properly to the following day.

5th Div. Op. Order No. 7. 30.8.14. Issued at 1 a.m., para. 2. "The 2 Bns. of the 19th Brig. at Pontoise together with a battery of the 8th Brig. will form the rearguard. The O.C. rearguard is responsible for seeing that the bridges over the canal and river at Pontoise are blown up. This will be done as soon as the bridge at Varesnes has been blown up by order of the Rearguard 3rd Div."

This sounds as if it might have been awkward for the rear party at Pontoise!

At 4 p.m. Lieut. Smyth, 17th Coy., got orders to take his section (No. 2) to prepare the bridges on the Noyon-Pontoise road.* The girder bridge over the *canal latéral* he blew up successfully, but at the suspension bridge over the Oise he was unfortunate. This seemed to be a straightforward job, although it was a big bridge, and the charge worked out at 2 or 3 slabs of guncotton to each of the four cables of the bridge (two of 2-inch round steel on either side). Result of explosion—*nil*. This was all the more annoying as Lieut. Smyth had only a small quantity of guncotton left. He sent off for more, but in the meantime made a second attempt, using 6 or 7 slabs on each of two cables on one side, as he had not sufficient to deal with all four. The result was a slight kink in the cables attacked. Not easily foiled, he set his sappers to work with felling axes on the wooden decking of the bridge, and collecting some paraffin or petrol from the neighbouring houses, tried to set it on fire, but this did not effect much damage, so for want of more explosives he had to leave the bridge as it was.

At 1 p.m. the C.R.E. 5th Div., who had just arrived at Carlepont, ordered the 59th Coy. to prepare the bridges at Varesnes for demolition. The company marched to Varesnes, where four bridges were found, three over the canal and one over the Oise. Lieut. Pennycuick,

* It was impossible to make sure from the diaries which Lieut. Smyth's two bridges were, but the Mayor of Noyon was kind enough to make the matter clear.

29th August (continued).

with No. 1 section, prepared the two-span girder bridge over the river (App. E.*a*) and No. 4 section the bridge over the *canal latéral* on the Varesnes-Noyon road, the work of these two sections being superintended by Capt. Johnston. The bridge over the canal half a mile west of this road was allotted to Lieut. Flint and No. 3 section, and that on the road from Varesnes to Behericourt to 2nd-Lieut. Carr and No. 2 section.

These were all girder bridges, and were ready by 11 p.m., but were not blown up until the order was given by the Rearguard Commander at about 6 a.m. on the following morning. Lieut. Pennycuick had to delay his explosion pending the arrival of 2nd-Lieut. Carr, who came down the road carrying his exploder, alone and greatly exhausted, some minutes behind the last of the infantry.

Another bridge over the canal in the neighbourhood of Varesnes was blown up by Lieut. Moores, 56th Coy., working with men of the 59th, but it is not possible to locate it, and the 56th Coy. diary states that it was not shown on the map. (App. E.*b*.)

On the evening of this day (29th Aug.), the II. Corps was in the neighbourhood of Cuts, and the bridge at Jussy, prepared during the night 26th/27th by the 59th Coy., was blown up by the cavalry.

G.H.Q. Operation Order No. 11 of this date, issued at 9 p.m., directs that "Corps Commanders will as far as possible destroy all bridges as they retire, taking care that the Cavalry is not cut off."

30th August.

On the 30th the I. Corps marched from St. Gobain to a position on the north side of the Aisne close to Soissons, and during the day sent the following order to their Divisions, and to the 3rd and 5th Cavalry Brigades, which were at this time under their command :—

> "Troops will halt for two hours after crossing the canal de l'Oise et Aisne. Bridges will be held as follows with infantry and mounted troops :—
>
> 1st Div. Ainzy* to Vauxhaillon.*
> 2nd Div. Pont-a-Courzon* to Crecy au Mont.*
> 5th Cav. Brig. continue to the right.
> 3rd Cav. Brig. continue to the left.
>
> Troops will not cross the Aisne to-day."

This was followed by another order :—

> ". . . it is necessary for the I. Corps to fall back. All troops must be withdrawn south of the river except light patrols. Bridges to be blown up at 3 a.m. if all quiet, but if there is any danger of their being rushed they will be destroyed at once."

Most of the troops, however, passed the night N. of the Aisne.

* Not shown on the accompanying map.

30th August (continued).

The II. Corps crossed the Aisne at Vic and Attichy, and reached Pierrefonds. At 4 a.m. before leaving Cuts, Capt. Henderson and Lieut. Wells, with a few men of the 57th Coy., had been sent down to the Oise at Bretigny to destroy the bridge. Finding two or three Uhlans on it, Capt. Henderson, with one of the sappers, drove them off, rescuing a man of the 59th Coy. previously captured by them. They successfully blew up the bridge. The diary of the C.R.E. 3rd Div. states that two bridges here (over the river and canal) were destroyed, but details of the canal bridge are not forthcoming.

The 59th Coy. left the neighbourhood of Varesnes very early on the morning of the 30th to follow the rest of the 5th Div. in the direction of Attichy. At about 8 a.m., when the company had rejoined the main column, and during a brief halt, Lieut. West, an officer dispatch-rider, rode up on his motor-bicycle with a note addressed to Major Walker from Major Buckle of the R. West Kent, to say that the suspension bridge at Pontoise was not completely demolished, and was still passable. Lieut. Pennycuick came up whilst Major Walker was reading the note, and immediately volunteered to go back with Lieut. West to see if anything could be done. The distance was about 8 miles. The motor-bicycle was loaded up with a box of 14 guncotton slabs, on the top of which mounted Lieut. Pennycuick with his pockets full of primers and detonators. Major Walker warned him that, if he could get to the bridge, the best place at which to attack the suspension cables was on the top of the piers. The two officers rode off, and passing first through the infantry rearguard and then the cavalry, reached the bridge, much relieved to find that the enemy had not yet arrived there. They climbed one of the piers to investigate, and Lieut. Pennycuick decided that, with the small quantity of guncotton they had with them, it was better to make sure of the job on one side than to attempt a demolition on both piers. There were twin cables on both sides of the bridge, each cable being of round steel some 2 inches in diameter. The whole charge of 13 slabs (one had fallen into the river) was fitted in between the two cables on the top of the left-hand pier, but the first attempt to set it off was a failure. The detonator fired, but the only result was that the primer broke up into powder. A fresh primer and detonator having been inserted, the second effort was successful, and, considering the small size of the charge, the demolition was a good one. The top of the masonry pier was blown off, and both the left cables were cut. This dropped the roadway into the water, and left it suspended on the right-hand cables only. In addition three or four of the ties on the right side of the bridge were broken, probably by flying fragments of masonry. It was a bold feat, and both officers were awarded the D.S.O.

30th August (continued).

At 7.45 a.m. the II. Corps issued orders to its Divisions and to the 2nd Cavalry Brigade, allotting billeting areas for the night south of the river Aisne, with outposts about one mile north of that river. All bridges were to be prepared for demolition, but at 9 a.m. another order went out that they were not to be destroyed. This must have been the result of some communication from G.H.Q., as at this hour a report was sent there to say that it was feared that all the bridges about Noyon had been destroyed. The Corps diary records that a message sent at this time saved Bailly bridge from destruction. (For Bailly bridge see page 221.)

At 2.15 p.m. the C.R.E. was told to prepare all the bridges over the Aisne in the 4th Div. area for demolition; the bridges are not specified, but they were presumably those at Vic and Attichy. At 9.25 p.m. he sent an order to the 7th Coy., "The charges on the bridges over the R. Aisne will not be exploded without orders from G.O.C. 4th Div. A firing party will be left on the bridges." There is nothing to show whether these bridges were destroyed or not.

4th Div. Operation No. 1 of the 30th (time not recorded, but it must have been very early) includes the following:—

"Para. 5. The withdrawal of the outposts will be arranged so that Pont l'Evêque is clear by 6 a.m.

6. The bridge mentioned in above para. will be blown up by the R.E. by order of Rearguard Commander 4th Div."*

The delays liable to occur in carrying out rearguard demolitions are well shown in the diary of the 4th Div. for this day. The troops of this division had begun to arrive at Carlepont at 11 p.m. on the 29th, and the rearguard (10th Inf. Brig.) was reported to be approaching the bridges at 5 a.m. on the 30th, when its commander (General Haldane) was informed from Divisional H.Q. that the bridge at Ourscamp was being blown up (orders for this had been issued) and that the Pimprez and Bailly bridges were to remain intact, but that all, or a part of the cyclist company was to be sent to these two bridges till his brigade was clear of Carlepont. At 8 a.m. a report was received at 4th Div. H.Q. from Gen. Haldane that one company of the Royal Irish Fusiliers had lost its way, and that he could not blow up the bridges until it had been found. At 9.10 a.m. Lt.-Col. A. A. Montgomery, G.S.O.2 of the Division, reported from Carlepont to his H.Q. that the 10th Brig. was still waiting to blow up the bridges at Sempigny until the lost company had reappeared. It must have turned up during the course of the morning, but the bridges between Pont l'Evêque and Sempigny were not blown up until half an hour after noon.

On the morning of the 30th G.H.Q. was still at Compiègne and the

* The destruction of these bridges has already been narrated (page 221).

30th August (continued).

C.-in-C. told Brig.-Gen. Fowke, Engineer Adviser at G.H.Q., that the bridge there was to be blown up next day at the request of the French. A wire was sent at 1.30 p.m. to the II. Corps, "Please send party of Engineers with necessary tools and explosives as rapidly as possible to Compiègne road bridge and prepare it for demolition, reporting arrival at Headquarters." In the meantime Brig.-Gen. Fowke reconnoitred the bridge—a fine structure dating from 1780, and capable of taking four lines of traffic, with a footpath in addition on either side—and ransacked the deserted offices of the Ponts et Chaussées for plans of it without success. Application was made to the French for explosives, which they promised to send, but added that there were at the moment none within 25 miles of Compiègne.

Capt. S. F. Newcombe, R.E., G.H.Q. liaison officer with the French for railways, now appeared, and Brig.-Gen. Fowke promptly took him on as his staff officer and put him in charge of the preparations. Next a French civilian came along, and pointed out where the demolition chambers were to be found, but nothing could be done until some sappers arrived to open up the road. Capt. Dobbie, Adjutant, R.E., 4th Division, next came on the scene, and Brig.-Gen. Fowke worked out the necessary charge as 1,200 lb. of guncotton. A wire was sent to the nearest depot (it is not stated where) for a couple of tons to be sent up immediately by train.

The order to the II. Corps must have been passed remarkably quickly through the 4th Div., the C.R.E., and the O.C. 9th Coy.,* as at 6 p.m. Lieut. Young, with some of his section, on bicycles, and accompanied by his tool cart, arrived at Compiègne. He was staggered at the job in front of him, and before learning of the existence of the demolition chambers, worked out the charge for a hasty demolition as 2½ tons !

At about this time Capt. Dobbie got hold of a French Territorial officer in a smart white summer uniform, who produced plans of the bridge, and the sappers started to pick up the *pavé*. As soon as the metal cover of the chamber had been removed, and the air inside tested, Capt. Newcombe was lowered down to explore. (Sketch App. G.) The guncotton had been sent off with remarkable speed, and now arrived at the railway station, which was close by, and sappers were sent with civilian carts to fetch it.

The difficulty in charging was that a man standing in one of the shafts (about 1′ 7″ in diameter) could not bend down to place the guncotton slabs with his hands, so had to trample them into position with his feet. As it was, of course, necessary to ensure close contact throughout the charge, Capt. Newcombe, in a simple working kit of shirt and cap, took on the job himself.

About 400 lb. of guncotton were lowered in sandbags down each

* The copy preserved is endorsed, "9th Fd. Coy. 2.15 p.m."

30th August (continued).

shaft, whilst Lieut. Young prepared the electrical circuit and duplicated it with safety and instantaneous fuze, the detonator and primer in each case being tied up with three slabs of guncotton in a sandbag. The French had played up in the matter of explosives, as a pile of boxes of mélinite was now discovered close to the end of the bridge, where it seems to have arrived unannounced. Some 50 kilos of this went down each shaft, and a top layer of three sandbags filled with gravel was added.

During the afternoon Sir John French came on to the bridge, and Gen. Fowke pointed out that it was a pity to destroy so fine a structure when an excellent bridging site for the enemy to use existed alongside. Sir John agreed, but said General Joffre insisted on its being destroyed.

All was ready at about 2 a.m. on the 31st, so the sappers and tool cart were sent away to try and find their company, taking with them all the surplus guncotton they could carry. Capt. Newcombe and Lieut. Young on the bridge, watched, dinnerless, till daybreak to see that the leads were not interfered with by passing troops or civilian traffic.

G.H.Q. left Compiègne during the night 30th/31st, and Gen. Fowke was told that the bridge was to be blown up as soon as all the cavalry had crossed. He was on the bridge early in the morning, when the cavalry and R.H.A. were still passing over, and seeing Gen. Allenby, commanding the Cavalry Division, told him what the orders were, and Gen. Allenby promised to send word when his men were clear. This message arrived at about 11 a.m., when Gen. Fowke gave Lieut. Young the order to fire the charge. The exploder failed,* but the alternative arrangement worked all right, though the 6 ft. of safety fuze burnt in 30 seconds.

The explosion caused hardly any noise, and had no shattering effect on the houses near by, but two fine arches of the bridge and the intervening pier had disappeared, leaving no visible debris above the surface of the water.

Lieut. Young got away, with his exploder and bicycle, in Capt. Newcombe's car.

At 3 p.m. on the 30th II. Corps sent to the 4th Div. (received 4.40 p.m.): "Please send Engineer officer to H.Q. II. Corps in the motor which brings this. He should have detail of explosives available for blowing up bridges. Four bridges have to be destroyed over the river Oise from Bailly inclusive to Compiègne exclusive. Motor lorries are available to take out working parties and explosives. Special arrangements are being made in addition for preparing the bridge at Compiègne for destruction. Further instructions will be sent after Engineer officer arriving here." This order was repeated by the

* When the exploder was examined some days later it was found that the contact breaker was damaged.

30th August (continued).

4th Div. to their divisional engineers, and is endorsed, " Personally to C.R.E."

II. Corps also sent at 5.55 p.m. to the 4th Div. (received 7 p.m.), " The bridges over the river Oise, Bailly (already prepared for demolition but charges withdrawn), at point one mile S.E. of Cambronne, at château one mile S.S.W. of Montmacq, and at point half mile N.W. of Choisy, should be destroyed under instructions to be issued by you so far as this is possible without engaging the enemy. We have no information of the enemy in this direction beyond that a small patrol of Uhlans has been reported in the neighbourhood of Giraumont. An escort of divisional cavalry seems advisable. Your 7th Coy.* has already been sent to prepare Compiègne bridge." To this is attached a pencil note by the C.R.E. 4th Division, " Seen and noted as regards the position of bridges. Two officers went off in a car to II. Corps H.Q. half an hour ago. I cannot yet say when the party will be ready to start out."†

Unfortunately these orders had come too late, as the bridge at Bailly turned out to be in the possession of the enemy. At 5.25 a.m. on the 31st, the 4th Div. reported to the II. Corps, " Detachment was sent to blow up bridges north of Compiègne, but has failed to accomplish task at any bridge. Bailly bridge was approached by R.E. party, which was fired on, and five out of eight were hit, including two officers. Compiègne bridge reported to be far too solid to be blown up."‡

The demolition party of the 9th Coy., under Lieut. Fishbourne, destined for Bailly, started from camp in a lorry at 9 p.m., to find their way in the dark by unknown roads, to a village they had never seen, to blow up a bridge that had not been reconnoitred by any of the party. As the infantry escort, which had been ordered by the Division, did not turn up, Major Barstow§ accompanied the party, taking an escort of two sappers. They left the lorry two miles outside Bailly, and proceeded on foot, but were fired on by a piquet at about 15 yards' range, with the result that Major Barstow was killed, and 2nd-Corpl. Stone so severely wounded that he could not be moved.¶ The remainder of the party returned to camp (three of them wounded) at 5 a.m., having been unable to blow up the bridge, which could have been destroyed earlier in the day by Capt. Westland without any trouble.

On this day the III. Corps was formed of the 4th Div. and the 19th Infantry Brigade, under the command of Lieut.-Gen. Sir W. Pulteney.

* Presumably Lieut. Young's detachment, 9th Coy., was referred to.

† It has proved impossible to trace who these two officers were, or what they did.

‡ A possible explanation of this is that Lieut. Young's sappers had been seen returning from Compiègne, and that one of them had said that the bridge was very solid, and had not been blown up when the party left.

§ O.C. 9th Field Coy.

¶ 2nd-Corpl. Stone was made prisoner, but eventually recovered from his wounds.

31st August.

On the 31st I. Corps crossed the Aisne at Soissons and west of that place, and their diary for this day records "Bridges from Fontenoy (inclusive) to Soissons (exclusive) destroyed by us during the night."* The 1st Div. diary states that the bridge at Bois Roger, 1 mile N.W. of Soissons, was blown up by the 23rd Coy., and those below by the 2nd Div., whilst the bridges over the river Crise, on the eastern flank of the B.E.F., were left to be dealt with by the French.

Lieut. Stafford and No. 4 section 23rd Coy. destroyed the bridge at Bois Roger at 5 p.m. (App. H.)

Lieut. Gowlland with No. 2 section 5th Coy. blew up the girder bridge at Pommiers at the same hour. (App. I.)

At 6 p.m. the C.R.E. 2nd Div. was ordered to destroy the bridge over the Aisne at Le Port,† three-quarters of a mile W. of Fontenoy, and Lieut. Perkins, with Serjt. Blanch and a few sappers of the 5th Coy., was sent there. This bridge had been reconnoitred during the afternoon by Capt. Dawson Scott, of the same company, but afterwards he had been sent elsewhere by D.H.Q., and his report had not been received. Meanwhile the bridge had been lost and regained by the K.R.R., and it was dark before Lieut. Perkins and his party reached the spot. Search was made for mine chambers which were reported to exist, but none could be found. As a result of the explosion the lattice girders were cut through, but did not fall. (App. M.)

At 6.40 a.m. the II. Corps reported to G.H.Q. the failure to blow up Bailly bridge and the supposed failure at Compiègne, but the diary records that Compiègne bridge was afterwards blown up at 11.15 a.m.

The III. Corps marched west and reached the neighbourhood of Verberie.

On the left of the B.E.F. was the Cavalry Division, and the Field Squadron was ordered to Port de la Croix St. Ouen to hold the suspension bridge over the Oise, and prevent hostile patrols from crossing from the west. This they did, and at the same time prepared the bridge for demolition, but could get no orders as to its destruction. Towards evening they were relieved by two squadrons of the Carabineers from Verberie, and the charges were withdrawn. At 8.30 p.m. the cavalry post on the bridge was rushed by the enemy, and during the night Uhlans appeared in the forest all round, so at 2.30 a.m. on the 1st September the Carabineers and the Field Squadron fell back south, moving through the forest by woodland tracks between the main road and the river.

* The night 31st/1st September must have been meant, but some were destroyed on the afternoon of the 31st.

† Not marked on the map.

31st August (continued).

The 2nd Cav. Brig. diary records that the bridge over the Oise at Verberie was blown up 3.30 a.m. on the 31st, but this was done by the French, who also blew up the railway bridge at Bois d'Ageux,* 1½ miles farther north.

1st September.

On the 1st September the I. Corps marched to La Ferté Milon, and the C.R.E. 1st Div. ordered the 23rd Coy. to prepare for demolition the more northern of the two bridges in the main street which carried the road over a lock on the Ourcq, here canalized, also the two foot-bridges over the lock gates close by. These were successfully blown up by No. 2 section by 11.30 p.m. on the same day, after the rearguard had crossed. (App. J.)

At 11 p.m. No. 1 section of the same company destroyed a steel girder bridge at Marolles, about a mile farther down the Ourcq. (App. K.)

The other two Corps continued their retreat, but no demolitions are reported by them on this date.

2nd September.

On the 2nd September the I. Corps kept west of the Ourcq, and in the evening the B.E.F. stood on a very restricted front with its right (I. Corps) north of Meaux. The II. Corps was in the centre, and the III. Corps on the left.

The 1st Div. diary for this day at 7.30 p.m. states that "the bridge over the Ourcq was of too solid construction to even contemplate its destruction," but it is not clear what bridge is meant, and the fact is not referred to elsewhere.

The 26th Coy. arrived at Meaux at 6.30 a.m., having marched 40 miles in 28 hours on the top of several days' retreat, and all turned in anticipating a good rest. When the O.C. had been in bed only a few minutes, he was wakened by Brig.-Gen. Fowke, who came into his room and told him that he would shortly get orders, through the usual channels, to destroy the bridges over the Marne. Leaving his men to rest, he turned out at once to reconnoitre the bridges, and at 1 p.m. the expected orders came from the C.R.E. to prepare them for blowing up, but to make arrangements to allow the whole division to pass before demolishing. At 2.30 p.m. he sent No. 3 section to cut down to the haunches of the arch (25-ft. span) of the main road bridge,† working on either side of the roadway, and leaving the centre for traffic, to be subsequently cut away after the division had passed. No. 4 section was detailed to destroy a light trestle

* Not shown on map.

† The Mayor implored the G.O.C., 3rd Div., that this bridge, dating back to 900 A.D., should be spared.

2nd September (continued).

footbridge, and No. 2 section started to cut down to the crown of the archway of the 100-ft. span masonry bridge. At 8 p.m. work was stopped, a pontoon bridge and the light trestle bridge having been destroyed, and as much work accomplished on the main bridges as could be done without impeding traffic. The company marched off at 4 a.m. on the 3rd, leaving an N.C.O. to point out the work done to the 2nd Division, who were to complete it. Actually the 57th Coy., 3rd Div., blew them up. (See page 235.)

The 11th Coy. marched through Meaux to Villenoy, where information was received from the C.R.E. 2nd Div. that the bridge there over the canal de l'Ourcq might have to be blown up. It was reconnoitred accordingly by 2nd-Lieut. Morris, but there is no record of its destruction.* On arriving at Esbly the O.C. was ordered to reconnoitre the road and railway bridges over the Marne, from the railway bridge at Isles les Villenoy to Dampmart bridge,† both inclusive. He allotted the bridges to his subalterns, and sent Capt. Skipwith to supervise those towards Dampmart, whilst he himself looked after those near Esbly. French sappers were found to be preparing, or to have prepared them for demolition, but this supervision appears to have been taken over later by the 59th Coy. (See G.H.Q. and II. Corps orders, quoted page 235.)

The following extracts from orders of this date are worth quoting at length :—

G.H.Q. Operation Order No. 14, issued at 7.30 p.m. :

" Para. 4. Corps Commanders will be responsible for the destruction of bridges over the Marne as follows :—

I. Corps, Changis to Trilport, both inclusive, and as far up-stream as possible.

II. Corps, Trilbardou inclusive, and all up-stream thence to Trilport exclusive.

III. Corps, Trilbardou exclusive, and all down-stream thence to Lagny inclusive. It is understood that arrangements have been made by the French to destroy bridges between Isles les Villenoy and Lagny inclusive, and that they have detachments posted at them for the purpose, but these detachments will act only on receipt of orders from British Commanders."

Thereupon II. Corps sent to their divisions at 10.32 p.m. the following order :—

" In accordance with G.H.Q. operation order No. 14 para. 4 of this date the II. Corps is responsible for the destruction of bridges

* Corps order subsequently brought this bridge into 3rd Div. area.

† The French map shows no bridge at Dampmart.

2nd September (continued).

over the river Marne from Trilbardou inclusive, and all up-stream thence to Trilport exclusive. The G.O.C. 3rd Div. will be responsible for the destruction of bridges at Meaux, and all bridges from Trilport exclusive down-stream as far as Villenoy inclusive. G.O.C. 5th Div. will be responsible for the destruction of bridges at Isles les Villenoy and Trilbardou and all bridges, including railway bridge, from Villenoy exclusive to Trilbardou. It is believed that some of these bridges have been prepared for destruction by the French. The Engineer officer detailed for duty at each bridge will consult with the French officer, and satisfy himself that this has been done, or will take such action as will ensure the destruction. He will be responsible for ordering the destruction of the bridges, and that all troops of the rearguard have crossed before the order is given."

In connection with this, II. Corps Operation Order No. 13, issued at 9.30 p.m. on the same date, is to be noted:

"Para. 8. A staff officer of each column will be stationed early at Meaux and Isles les Villenoy bridges respectively, and will place himself in closest communication with the French officer charged with the destruction of the bridge, in order to prevent the bridge being blown up before the rearguard clears."

It would be interesting to know the instructions given to the French officers by their higher authorities, and from whom they were prepared to accept the order to "press the button." On the British side, the responsibility seems to have been shared by two officers.

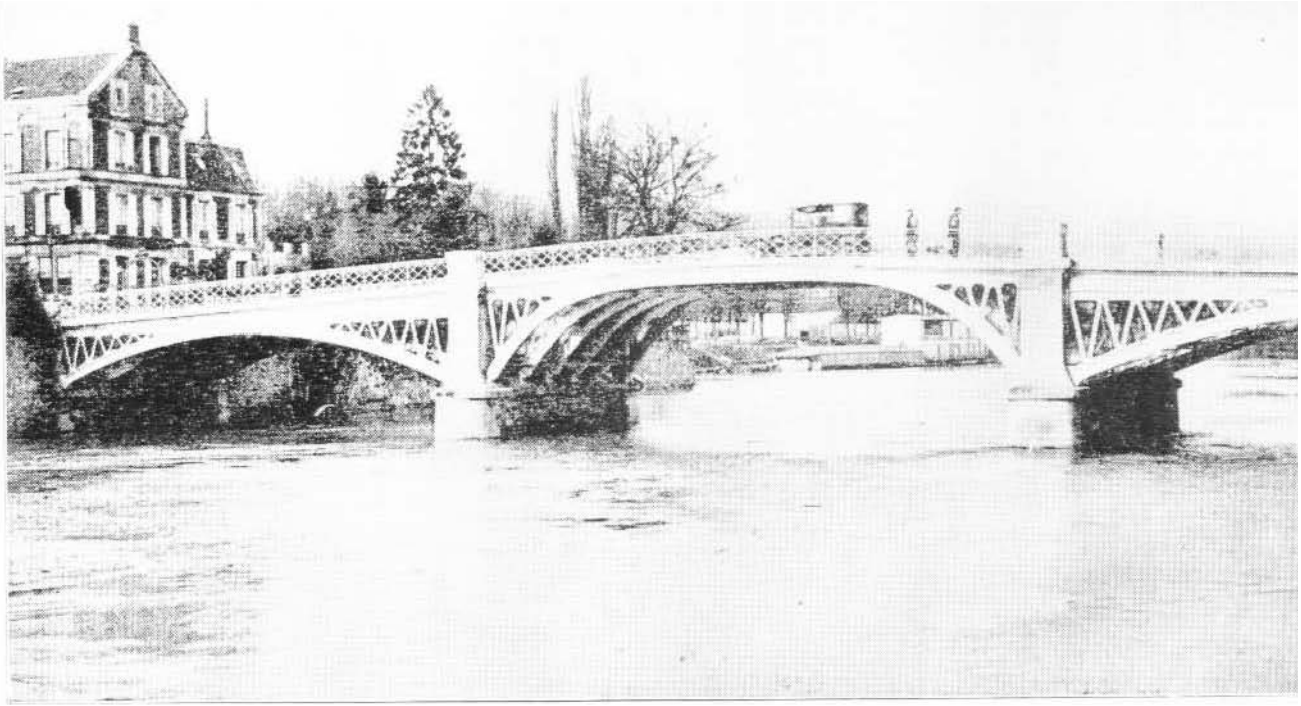
A small bridge ¼ mile W. of Trilbardou was blown up by Lieut. Flint, 59th Coy., it being regarded as within the 5th Div. area.

On this day, when the 1st Field Squadron was marching south through Ermenonville, on the west flank of the B.E.F., the O.C. was asked to destroy four German guns found abandoned in a wood E. of that village. A small party was galloped up with explosives on pack horses, 3 lb. of guncotton was stuffed into each breach, the breech blocks closed as much as possible, and the muzzles of the guns stuffed with sods. All the chambers were blown out of shape, cracked, and twisted.

No case of roads having been blocked by the demolition of houses is recorded in detail in the diaries, but in the course of correspondence the following incident has come to light, and, in view of the importance of roads at the present day, is worth narrating in full.

On the 2nd Sept. at 3 p.m. Lieut. Pennycuick was sent to Iverney,* 5 miles N.W. of Meaux, with a party of 16 men of the 59th Coy., some on bicycles and some carried on the ever-useful pontoon wagon.

* Not shown on map.



Demolitions carried out at Mons

2nd September (*continued*).

They arrived towards evening, and found a rearguard of the Manchesters in occupation for the night. They first made the usual block across the road with ploughs, harrows, etc., tied them together with wire, and smashed the wheels with a heavy hammer. At the same time they prepared for felling 6 or 8 trees of 9-in. to 12-in. diameter, choosing those leaning in towards the road, and inserting a 1-lb. slab of guncotton in a cut made in each tree on the side facing the road, the slab being fitted in tight with earth to make good contact. These charges were touched off on the following morning, when the patrols of the South Irish Horse had come in, and in every case the tree fell right across the road, as intended.

For their main block Lieut. Pennycuick selected a spot in the village where the road narrowed and took a slight turn, and here he prepared three houses for demolition, two of stone on one side of the road and one of brick opposite them. It was not his intention to blow the houses "up," but to amass debris in the road, so the charges were calculated—with a bit to spare—to cut the walls facing the road in lengths of 10 to 12 feet. There was no need to hurry the work, which took about two hours, and when all was ready the party slept peacefully in the prepared buildings, the detonators not yet having been inserted. In the morning all the charges went off except one. There was now no time to wait, so Lieut. Pennycuick and Corpl. Guinan went into the house and withdrew the detonator, when it was found that the failure was due to a defective joint between the safety and instantaneous fuze. This charge went off all right at the second attempt, and a very complete block was achieved. It is worth noting that the Mayor, or his deputy, had ordered out the inhabitants, and helped them to remove their more valuable belongings during the night.

3rd September.

The B.E.F. crossed the Marne on the 3rd Sept., the 1st Div. at Trilport, the 2nd and 3rd Divns. at Meaux, the 5th at Isles les Villenoy, the 4th at Lagny, and the Cavalry at Gournay, a front of about 30 miles. In the evening it lay on a line extending from La Ferté sous Jouarre to south of Lagny.

G.H.Q. diary states that the bridges between Lagny (exclusive) and Trilport (inclusive) were destroyed by request of the French.

After crossing the Marne at Trilport and Meaux the I. Corps turned E. and marched on La Ferté sous Jouarre.

At 12.10 a.m. the C.R.E. 1st Div. got orders to prepare the bridges at St. Jean-les-deux-Jumeaux and La Ferté sous Jouarre for demolition. At 4.45 a.m. he sent the 23rd Coy. to St. Jean and Sammeron, and the 26th Coy. to La Ferté, riding on ahead himself to La Ferté to reconnoitre.

3rd September (continued).

The O.C. 23rd Coy. was told to send in a report when the bridge at St. Jean was ready, and to follow the column, leaving a party to blow it up if ordered, or to inform the cavalry as to the work that had been done. Lieut. Mallins went to St. Jean, and 2nd-Lieut. Parkes to Sammeron, the latter bridge being ready by 11 a.m. Each of these bridges was successfully demolished. (App. L. and N.)

The C.R.E.'s reconnaissance reports on the bridges at La Ferté ous Jouarre are in Appendix O.

On arriving at La Ferté the O.C. 26th Coy. set No. 1 section to test the electrical gear whilst acting as escort, No. 3 to bring over all boats,* etc., to the south bank; No. 4 section to attack the stone arch bridge, whilst No. 2, under Lieut. Wingate, tackled the girder bridge. This was formed of six arched girders, a somewhat unusual type, but he thought that if he followed out the C.R.E.'s instructions the girders would fall.

Both bridges were ready at 6.54 p.m., but orders came that they were not to be demolished, and that the charges were to be withdrawn. The O.C., however, wisely ignored the latter part of this order, as it did not come from the C.R.E., and, sending away the sappers, left Lieut. Smith on the stone arch bridge and Lieut. Calthrop on the girder bridge, with instructions that they were not to fire without orders from their D.H.Q. The necessary order was included in those for the following day's march, and reached the O.C. Coy. at 4 a.m. on the 4th. He went down at once to the bridges, and found that Lieut. Calthrop had already received the order through the company of the Coldstream Guards posted on the girder bridge, and had fired his charge. Lieut. Smith was in the act of clearing the men off the stone bridge to do the same, and the demolition of the arch was completely successful. That of the girder bridge was not satisfactory: the girders were cut clean through, but, acting as cantilevers, they still managed to support the roadway, in which there was only an incomplete gap a few feet wide, so that the bridge was passable for infantry. Just as the examination of the damaged girders had been completed, some Uhlans arrived on the farther bank, but they were driven off by the fire of the Guards.

The O.C. Coy. sent for his No. 2 section and more explosives, whilst the other sections marched off with the Division, and one Company of the Coldstream Guards remained as rearguard at the bridge. Judging by the experience gained during the afternoon it would have taken four hours to prepare the girders for cutting through at a fresh place, so, as it was still dark and the rearguard could not wait much longer, he decided to try the effect of a heavy charge on the ends of the severed girders jutting out from the pier. A separate charge of guncotton, tied on a plank, was placed on each of the six

* Some of these boats were used by the R.E. when bridging the Marne here a few days later.

3rd September (continued).

girders, 100 lb. in all, but unluckily, whilst this was being done, one of the sappers in clearing away the roadway to enable the charges to be fixed to the girders, struck a spark, which lit the gas in a large main broken by the explosion. This continued to burn until the end of operations. All six charges were connected up in series and exploded electrically, but the only result was to increase somewhat the gap in the roadway, which the sappers proceeded to widen by means of bars and pickaxes. The C.R.E. then came on the scene, and as the rearguard could wait no longer, he gave the order to cease work and retire. A German battalion crossed this bridge at 9 a.m. the same morning, but did not press on.

At 2 p.m. the C.R.E. 1st Div. asked the 3rd Cav. Brig. to inform the R.E. officers in charge of the bridges at St. Jean and Sammeron of the exact time at which they were to be blown up, pointing out that if the cavalry were not directly protecting these bridges, it was very desirable that they should be blown up not later than 6 p.m., as there were only small posts of sappers on them. At 5 p.m. he appears to have been informed direct by the II. Corps that bridges not already destroyed were not to be blown up without further orders, as he sent a copy of the message to 1st Div. H.Q., and at the same time asked the 3rd Cav. Brig. to instruct the R.E. detachments at St. Jean and Sammeron to rejoin their company, bringing with them their detonating apparatus, but leaving the guncotton in position. The bridges, however, had been blown up at 6.30 p.m., before this message arrived.

The situation apparently changed during the night, as at 3.30 a.m. on the 4th he sent his companies the following message: "1st Div. order No. 15 will go to you through your group commanders. Division moves south to-day, all Marne bridges prepared for demolition to be blown up as soon as the patrols on the north bank have been withdrawn. Please take necessary action with troops concerned."

The 2nd Div. passed through Meaux, and the 5th Coy., having borrowed 200 lb. of guncotton from the 11th Coy., marched to Trilport to blow up the bridges there behind the 1st Div., whose R.E. companies were pushing forward to other work as already described. Lieut. Perkins took on the road* bridge and Lieut. Gowlland the railway bridge. (App. O.) Both bridges were successfully destroyed.

In the 3rd Div. the 57th Coy. continued the preparations begun by the 26th Coy., on the previous day, for destroying the bridges at Meaux, laying the charges on half the road at a time whilst the two divisions crossed. Their demolition was successfully effected at 5 p.m., also that of a 3-span footbridge, whilst "the bridge leading to the cornmill" was partially destroyed. This company destroyed

* The preparations for the demolition of the road bridge had been begun by the 4th Field Troop.

3rd September (continued).

(or superintended the destruction of) all the bridges, weirs, barges and boats on the canal between Villenoy and Trilport.

When the 5th Div. had completed its crossing at Isles les Villenoy the road bridge was very thoroughly blown up by the French in the presence of the O.C. 59th Coy., at about 11.30 a.m., but no staff officer ever turned up. The road from the south rises steeply to the bridge, and a car coming along from that direction at full speed, after the explosion, went headlong into the gap, the incident being witnessed by two men of the Irish Guards cut off on the farther bank. The story goes that the car was full of photographic films, which a German spy was trying to get through to their lines.

One of the bridges at Trilbardou was blown up by the French in the presence of Lieut. Flint, 59th Coy., but at the other the French officer refused to act on a request from Capt. Johnson, alleging that he could destroy the bridge only on an order from the Governor of Paris, but on being confronted with the G.O.C. 3rd Div. he relented. His first attempt missed fire, but the second was successful.

During the afternoon the O.C. 17th Coy. reported to the C.R.E. 5th Div. that the French officer on the railway bridge at Isles les Villenoy similarly declined to blow it up without an order from the Governor of Paris. This was sought through " the usual channels," including G.H.Q. and G.Q.G., with the result that the C.R.E. was aroused at 3 a.m. on the 4th, and ordered to go and blow up the bridge himself, a car being placed at his disposal (an unusual luxury in those days). At the railway station he met a veteran French major, who said that he had been sent down by the Governor of Paris, and was looking for the officer who should be there to blow up the bridge. In a dense fog they carefully stalked the bridge, walking one on either side of the line, but found no one there. The demolition officer, who had retired from the bridge on the previous evening on the approach of Uhlans, now returned with his party, but, whilst he was making his preparations, a woman arrived from a village 300 yards north of the river, and said that there were British soldiers there. These turned out to be three stray cavalrymen (one wounded) and the two men of the Irish Guards mentioned above—probably the Uhlans of the previous evening. The demolition was very successful, the track being torn up on either side of the gap. During operations an officer with a party of cyclists came along from a neighbouring division to act as a covering party : they were a bit late, but it was a thoughtful act of co-operation.

All boats on the river near Meaux were sunk by the 17th Coy., 2nd-Lieut. Godsell working east and Lieut. Smyth west of the road bridge.*

In the III. Corps, the 4th Div. received orders to blow up the bridge at Chalifert, but these were cancelled later, as this was to be done by the French.

* Apparently in the 3rd Div. area.

3rd September (continued).

In G.H.Q. Operation Order No. 15 of this date, issued at 11.50 p.m., para. 6 ran as follows:—"All bridges in front of the army will be destroyed forthwith, see para. 4 of Operation Order No. 14 of 2nd Sept. 1914." (See page 231.)

4th September.

On the 4th Sept. the III. Corps stood fast at Lagny, but on the right flank the I. Corps fell back to Coulommiers, where the bridges were reconnoitred by 2nd-Lieut. Manley, 26th Coy. He reported that there were three of importance, and that they would require 180 lb., 188 lb., and 110 lb. of guncotton respectively. There is no record of their destruction.

In accordance with instructions from the II. Corps, the 4th Div. sent a cyclist with a written order to the French officer at Chalifert to blow up the railway bridge, and this was done at 8 a.m. The O.C. Cyclist Platoon reported to 4th Div. H.Q. that the road bridge at Isles les Villenoy had been blown up the previous night,* and the railway bridge at 8.15 a.m. on the 4th.

5th September.

No further demolitions are recorded, as at 3 a.m. on this day General Joffre's instructions for offensive operations to begin on the 6th reached G.H.Q., and there was no longer any necessity for such work to be carried out.

In conclusion, I wish to thank my 38 correspondents, some of whom I have pestered with a succession of letters in my attempts to reconcile conflicting statements in the official diaries. Without the help which they have so kindly given this record could never have been compiled.

CORRECTIONS.

Page 37 of the March number of THE R.E. JOURNAL.

It has been pointed out that the list of the officers of the 1st Field Squadron is not correct. The 4th Field Troop never formed part of the 1st Field Squadron. It was mobilized at the Curragh in August, 1914 (Capt. L. Chenevix-Trench, Lieuts. T. A. S. Swinburne, K. MacL. Carnduff), and on arriving in France was attached to the 5th Cavalry Brigade, which did not form part of General Allenby's Cavalry Division. The 2nd Field Squadron landed in France on 10. 10. 14, and the 4th Field Troop was then absorbed into it. The date in the footnote on page 19 should be March, 1914.

It is regretted that, owing to a printer's error, the photograph of La Ferté sous Jouarre Bridge appeared with the first part unnamed.

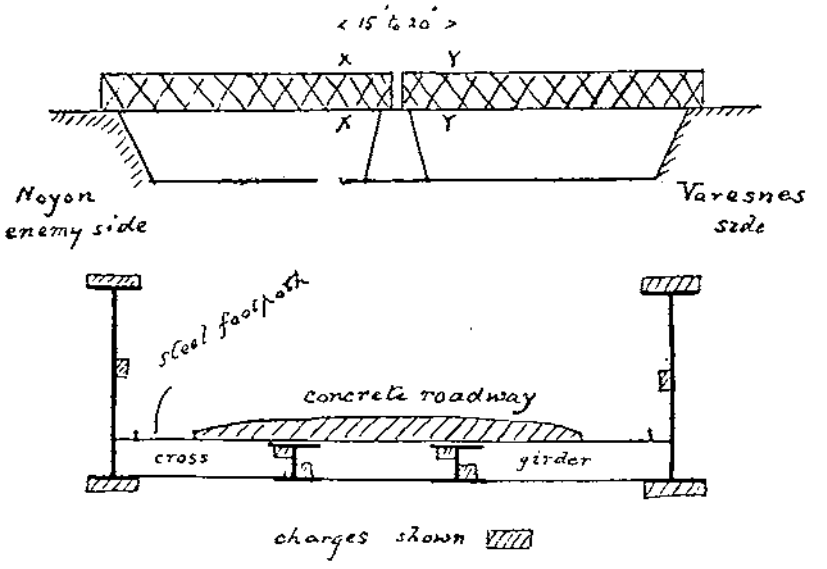
* It was blown up at 11.30 a.m. on 3rd September; see page 236.

APPENDIX E.

(*a*) Bridge over the Oise at Varesnes.

(From memory by Major J. A. C. Pennycuick, D.S.O.)

Charges at XX and YY, on separate circuits, two exploders (one borrowed from the 56th Coy.) being available. XX were fired first, so that in case of failure they could be reached and put right, and YY immediately it was seen that XX had gone off, and before the falling debris had time to break the leads. One exploder could not have coped with the two sets of charges simultaneously, there being 12 (or more)



detonators in each circuit. Dimensions cannot now be given, but the girders were deep and had thick flanges. The charges were calculated to cut the flanges, and nothing was placed on the lattice web except in the centre, where there were steel stiffeners. Planks were suspended under the bridge, by means of ropes from the lattice girders, as a platform for the sappers to work on.

(*b*) Bridge over the *canal latéral* near Varesnes, not marked on the map.

Steel lattice girders, charges placed in opposite angles of girders, and at junction of cross pieces of the webbing. Top and bottom flanges similar. Roadway 15 ft. wide, wheel tracks supported by longitudinal girders, which were believed to be 1 ft. deep with 4-in. flanges. No charges were placed on these girders.

Calculations :—

$$\text{Top of flange, } \frac{3}{2}Bt^2 = \frac{3}{2} \times \frac{57}{96} \times \left(2\tfrac{1}{8}\right)^2 + \frac{3}{2} \times \frac{63}{96} \times \left(1\tfrac{3}{4}\right)^2$$

$$= \frac{3}{2}\left(\frac{57 \times 17^2}{96 \times 64} + \frac{63 \times 49}{96 \times 16}\right)$$

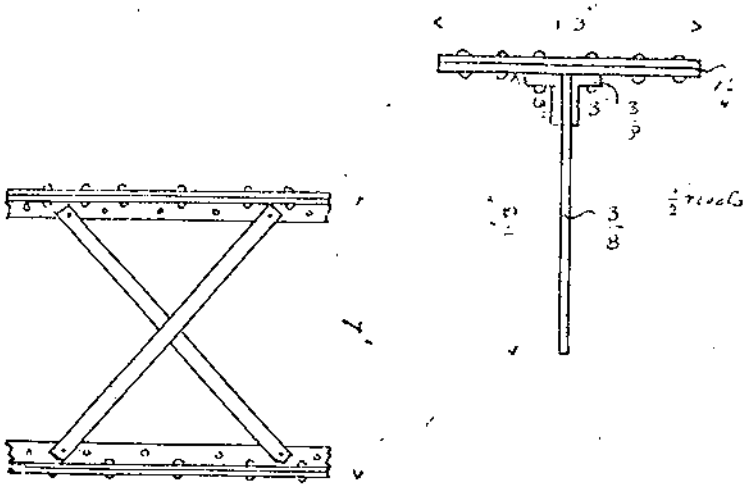
$$= \frac{3}{2}\ (5 \text{ lb.}) = 7\tfrac{1}{2} \text{ lb.}$$

Vertical of flange, $\frac{3}{2} \times 1 \times \left(\frac{3}{8}\right)^2 + \frac{3}{2} \times \frac{1}{4} \times \left(\frac{9}{8}\right)^2$

$$= \frac{3}{2} \times \frac{9}{64} + \frac{3}{2} \times \frac{1}{4} \times \frac{81}{64}$$

$$= 1 \text{ lb. (say).}$$

$7\frac{1}{2}$ lb. + 1 lb. = 8 lb. add 50% = 12 lb.



Charges used on each girder—Top flange ... ... 12 lb.
Centre webbing ... 6 lb.
Bottom flange ... 12 lb.

Each girder ... ... 30 lb.

Total charge ... 60 lb.

Result: The destruction was complete.

APPENDIX F.

Bridges over the Oise and the canal latéral between Pont l'Evêque and Sempigny.

(*a*) Main road bridge over the canal.

Lattice girders, single span 70 ft., and a somewhat narrow roadway. Total charge 80 lb., both girders (top and bottom) being attacked. Exploder failed to set off the charges. Those on the bottom booms were then fired by safety fuze and successfully cut, but the girders did not fall until a second explosion cut the top booms.

(*b*) Bridge over the canal west of the main road.

Similar arrangements as in (*a*); the exploder fired all four charges, and the girders fell.

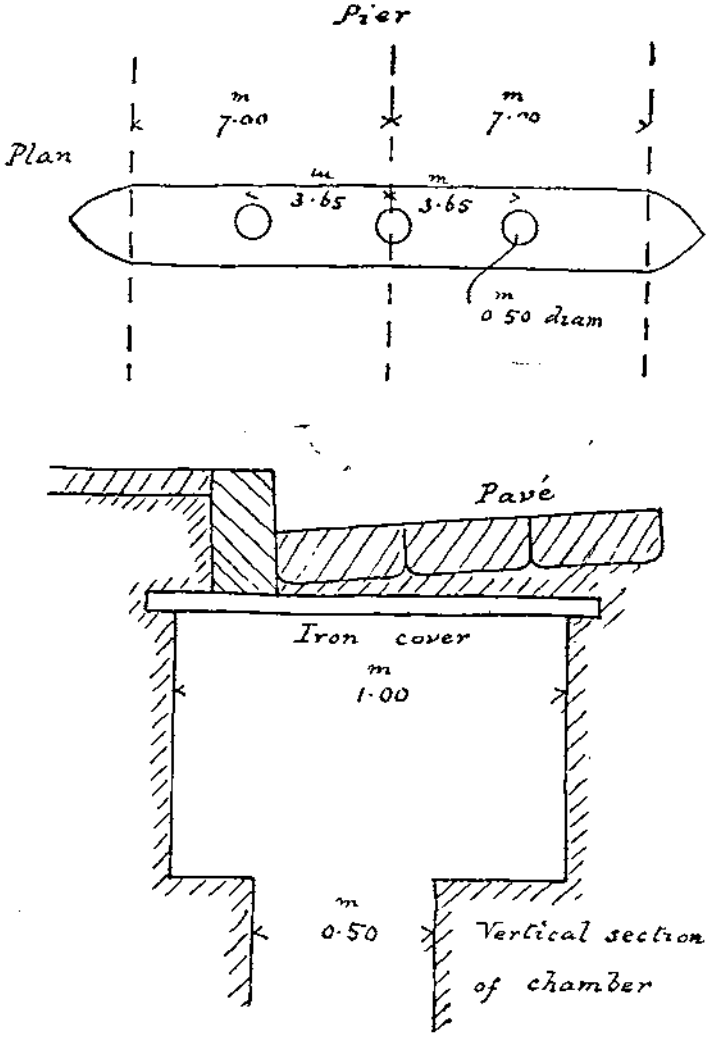
(*c*) Bridge over the Oise at Sempigny.

An old stone bridge of three arches, each of about 25-ft. span, and 17 ft. wide over all. Arch rings 2 ft. 6 in. thick with deep and heavy filling above. Attached to the side of the bridge was a narrow steel

footbridge carried on steel beams, which served to support regulating sluices. The charges were 230 lb. each, fixed under the northern haunches of two successive arches, plus a few pounds on the footbridge. Nine detonators in series were successfully fired by the exploder, but the bridge was only seriously damaged, not wrecked. One arch was again attacked with an 80-lb. charge. It was whilst this was being fixed that the Uhlans appeared, as described in the text, but the charge was successfully fired.

APPENDIX G.

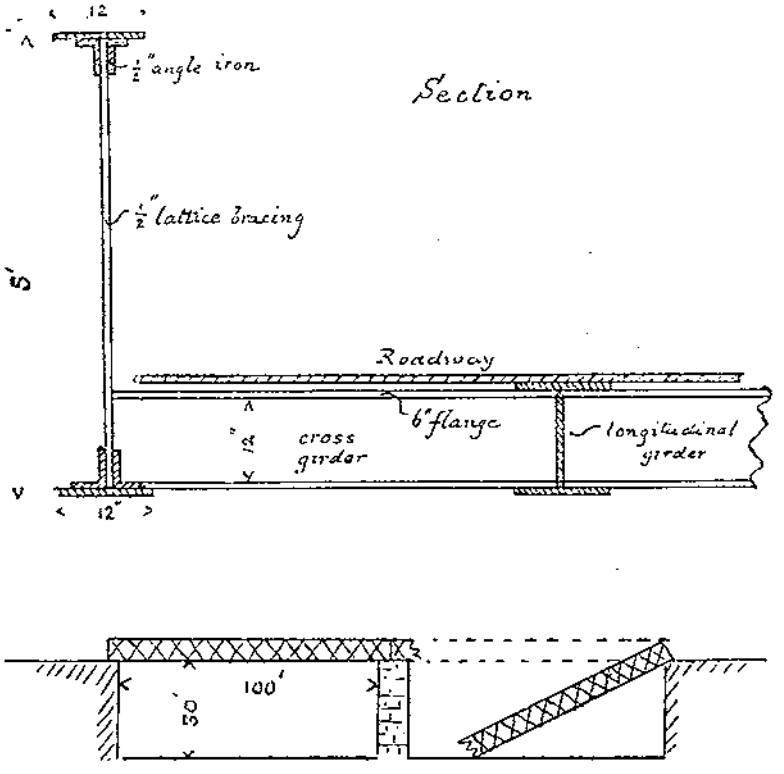
DEMOLITION CHAMBER AT COMPIÈGNE.



APPENDIX H.

BRIDGE OVER THE AISNE AT BOIS ROGER, 1 MILE N.W. OF SOISSONS.

Lattice girder, 30 ft. above water level, two spans of 100 ft. each. Approximate section of main girders as shown. Between these there were two small longitudinal girders with cross girders at intervals,



supporting a roadway of 1½-in. planks. The masonry pier in the centre had been prepared for demolition by gunpowder some years previously, but the key of the chamber could not be obtained for half an hour, and gunpowder was not available.

In view of possible attack, there being no covering party, speed was essential, and it was decided to blow down the S.E. span only, attacking it close to the central pier.

Charges were placed so as to cut the two main girders at their top and bottom flanges (12 slabs g.c. each), also the two longitudinal girders (3 slabs along each web), making a total of $4 \times 12 + 2 \times 3 = 54$ old

pattern g.c. slabs, fired electrically by 6 detonators in series. Time taken, 1½ hours. Result: demolition complete, the ends of the girders falling into the river 30 ft. below.

APPENDIX I.

BRIDGE OVER THE AISNE AT POMMIERS.

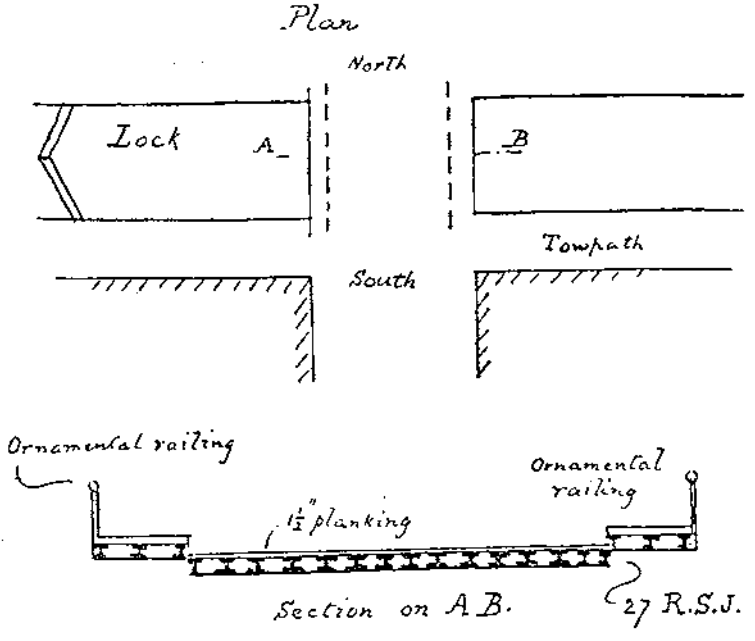
Steel bowstring girder, through span of 140 ft., attacked 30 ft. from south end, where depth of girder was about 14 ft.

Charge, 42 lb. guncotton, fired electrically. Result: Demolition satisfactory, girders cut and dropped.

APPENDIX J.

BRIDGE OVER THE OURCQ AT LA FERTÉ MILON.

(From Major Bond)

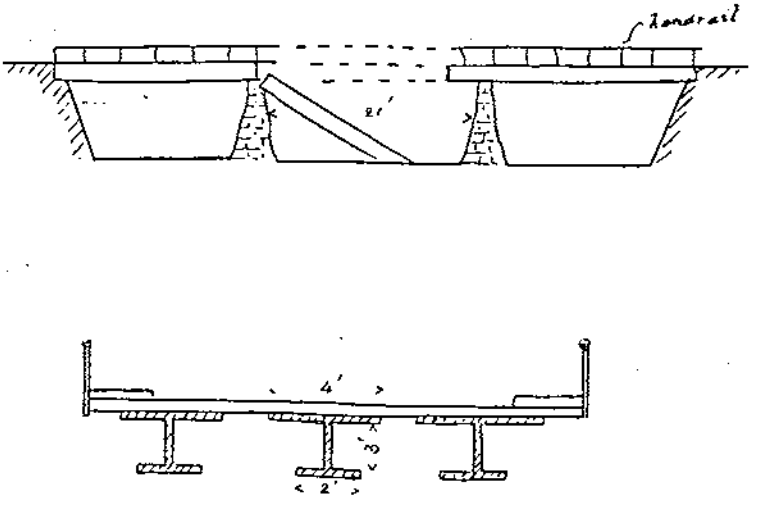


Charge, 1 slab and detonator per R.S.J. 13 R.S.J.s only were attacked in the first instance, and the remainder later, as the exploder was not capable of firing 27 charges simultaneously. Result: completely successful.

APPENDIX K.

BRIDGE OVER THE OURCQ AT MAROLLES.

Steel girders, 3 deck spans of 21 ft. each, 3 girders to each span, top flange 4 ft., web 3 ft., bottom flange 2 ft. Attacked close to a pier. Charge, 20 lb. per girder, total 60 lb., packed against the web and flanges in the usual way. Fired electrically. Result: all three girders cut through, and end of span fell into the river.



APPENDIX L.

BRIDGE OVER THE MARNE AT ST. JEAN-LES-DEUX-JUMEAUX.

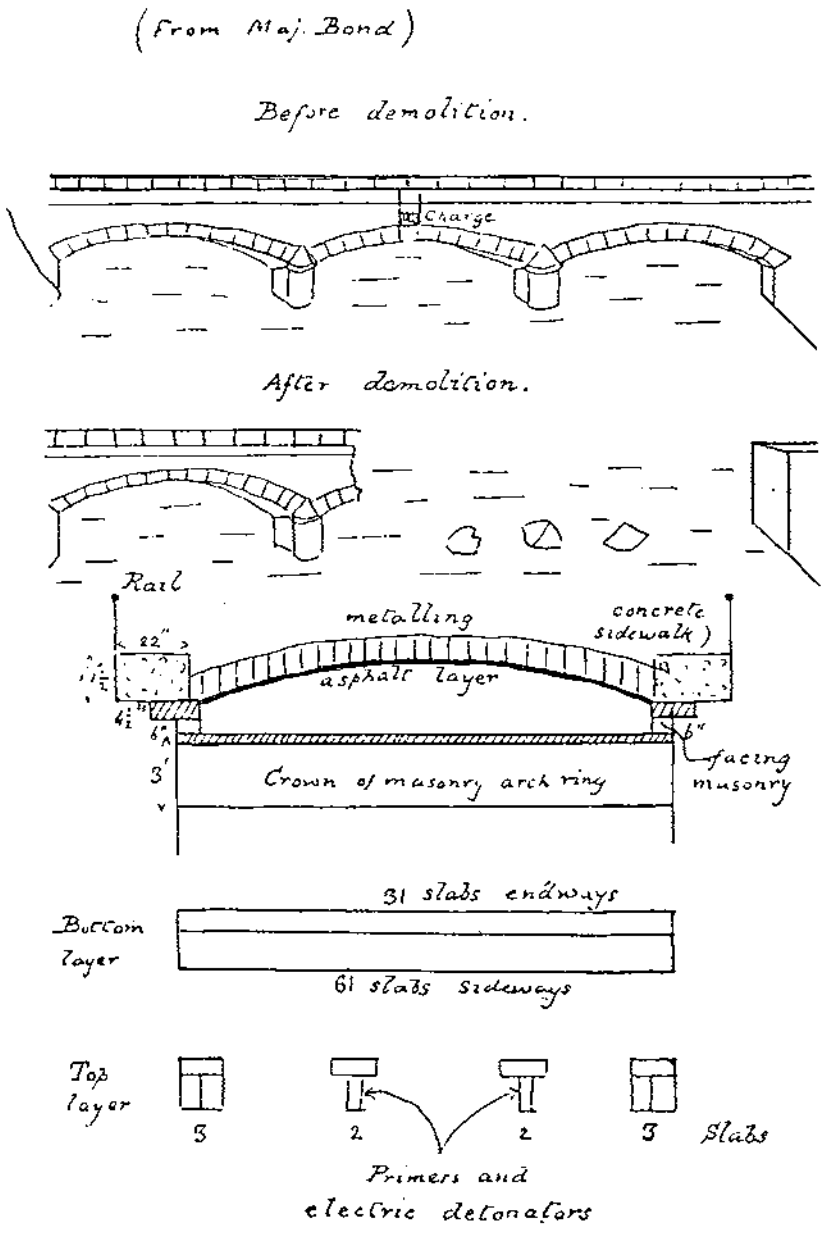
Masonry bridge of 3 spans, each of 78 ft. between centres of piers. Width not stated.

A ditch 18 in. wide was dug across the road, and through the concrete sideways, the small brick supporting arches, and the stone facing on either side. This ditch was boarded over to carry the traffic during operations.

Charges, 112 lb. guncotton tied to a board and placed, board downwards, on the arch ring, the inequalities being packed with earth. It was tamped with the material dug out. Two primers with electrical detonators were used in series. Wires and exploder were tested with an electric detonator, and the wires were led from the charge along the western handrail to behind a house, where the exploder was attached to them. Work commenced at 8.30 a.m., charge ready at 1 p.m., fired at 6.30 p.m.

Result: two-thirds of the centre arch was blown away, and the other spans cracked right across near the haunches, both at piers and

abutments. About three minutes later the cracks in the far span opened out, the handrails broke, the pier toppled over into the river, and dropped

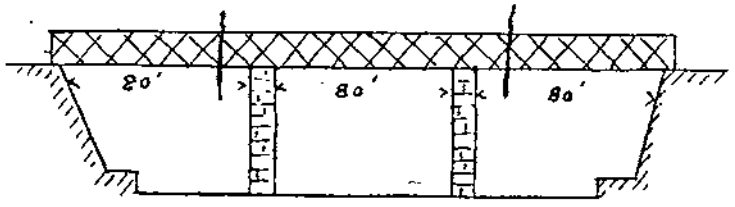


the further span into the stream, tearing it right away from its abutment. The nearer span was badly cracked, and likely to give way at any moment.

APPENDIX M.

BRIDGE OVER THE AISNE AT LE PORT, ¾ MILE WEST OF FONTENOY.

Lattice girder bridge, 3 spans of 80 ft. each, the girder being continuous.



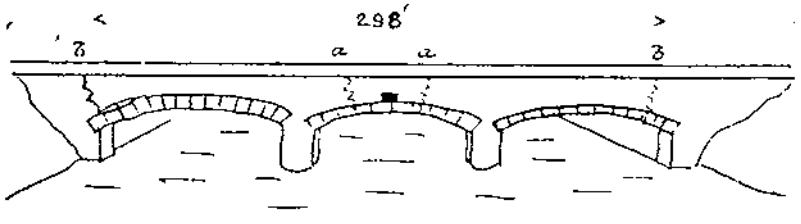
Men, tools, and time available did not permit of the removal of the roadway. The two shore spans were attacked; charges 48 lb. on each span. Fired electrically. Result: both girders of both spans completely cut through, and portions of the roadway near the girders destroyed, but the remainder of the roadway, left intact, sufficed to prevent the girders from falling.

APPENDIX N.

BRIDGE OVER THE MARNE AT SAMMERON.

Three masonry arches totalling 298 ft., width of roadway 18 ft., arch rings 3 ft. thick.

Roadway excavated down to corwn of masonry arch, charge of 110 lb. guncotton laid along it, and tamped wet (*sic*). Fired electrically. Result: whole bridge demolished, including both piers.



APPENDIX O.

BRIDGES OVER THE MARNE AT LA FERTÉ SOUS JOUARRE.

RECONNAISSANCE REPORTS BY THE C.R.E. 1ST DIVISION.

(*a*) West bridge, over which light railway passes.

Stone arch bridge, 3 spans of 93 ft. each, thickness of arch ring 4 ft., width of road 21 ft., and in addition it had 3-ft. pathways cantilevered out on either side. Depth of roadway to crown of arch 3 ft.

$$C = \tfrac{3}{4}(B\ T)^2 = \frac{3 \times 21 \times 16}{4} = 252 \text{ lb. (for crown).}$$

Result: completely successful.

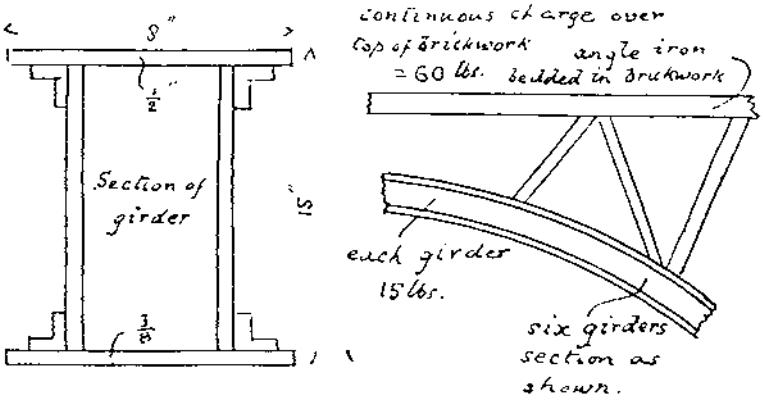
(*b*) Bridge in centre of town.

Three iron cantilever arches of 75-ft. span on masonry piers. Width 28 ft. Each arch consists of 6 girders.

Attack one haunch of centre span.

Total charge :—

Over brickwork	...	...	...	60 lb.
Girders	...	...	...	90 lb.
Total	...	...		150 lb.



APPENDIX P.

BRIDGES OVER THE MARNE AT TRILPORT.

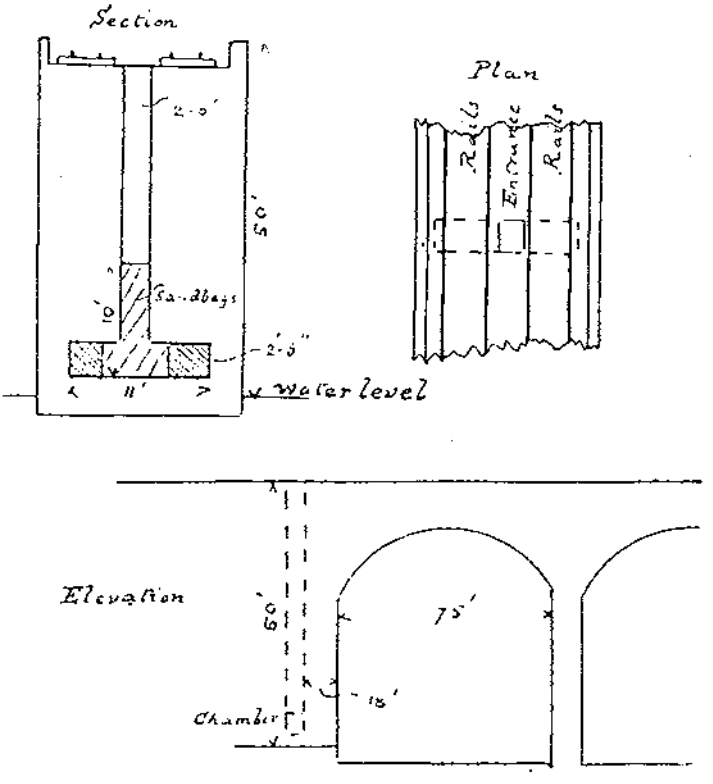
(*a*) Road bridge. Three masonry arches, each of 57-ft. span, arch ring 4 ft. 6 in. thick, 5 ft. under the foot of the parapet walls. Crown of eastern arch attacked. Trench 33 ft. long dug across the bridge, half being prepared at a time and decked over for the passage of the troops which was never checked. Picking up the road was laborious and slow, tools were double banked, and men relieved at frequent intervals. Arrangements had to be made for tools to be resharpened throughout the work. The traffic control at both ends of the bridge was very good.

Charge, 350 lb. of guncotton, well tamped with earth, paving stones, and large stones from the parapet walls. Fired electrically. This excessive charge was used as the bridge appeared to be very massive, and it was important to avoid any risk of failure. Result: demolition completely successful, practically whole arch ring removed, and the greater part of the pier and abutment fell away.

(*b*) Railway bridge.

Three masonry arches, each of 75-ft. clear span, arch ring 4 ft. 3 in. thick.

The original intention had been to attack the haunch of one arch, but when the excavation had been going on some time a French civilian pointed out an existing demolition chamber. The entrance to this was



on the top of the embankment, between the double line of rails, and on the trap door was inscribed the weight of mélinite required to destroy the bridge.

The 350 lb. of guncotton available were not the equivalent of the mélinite charge prescribed, but the demolition was completely successful, the abutment was entirely demolished, and nearly the whole arch fell.

Time taken : 3 hours from the finding of the chamber.

COMMENTS ON THE FOREGOING DEMOLITIONS.

By MAJOR I. S. O. PLAYFAIR, D.S.O., M.C., R.E.

THE object of these comments is to draw attention to a few points that may be of interest and importance in the future. They are in no way intended to be armchair criticisms of the very gallant (and almost always successful) feats narrated above.

Page 223, 56 *Fd. Coy.*—Even in a country as well surveyed as this there was a bridge that was not marked on the map. This points to the advisability (if time permits) of reconnoitring lengths of river, and not merely the marked crossing-places.

Pages 222 *and* 224, *Pontoise Suspension Bridge.* One of the disadvantages of guncotton slabs is the difficulty of arranging for good contact with steel cables. The difficulty is greatly increased when one is perched up precariously in mid-air. At Pontoise each cable seems to have consisted of a pair of steel rods or ropes about two inches in diameter. Whichever they were the amount of guncotton required to cut them according to the present formulæ would be about three slabs per rod or rope of the cable. It is not evident what sort of firing circuit was used in the first two attempts; the failure at the third attempt may have been due to a wet primer, as the detonator seems to have gone off while the primer did not.

Experiments have shown that the way in which the calculated number of slabs are disposed on the cable has a great effect upon the result. For instance, where the calculated number is three it has been found best to place one slab longways in contact with the cable, with the other slabs upon the first one. If the three are arranged to enclose the cable (in three sides of a box, as it were) the effect is greatly reduced. Slabs placed opposite to one another have a definite "cancelling out" effect. The "staggered" method shown on Plate 22, *M.E.*, Vol. IV, is particularly suitable for large cables.

Page 226, *Compiègne.*—This fine old bridge (being so near to G.H.Q.) received a great deal of distinguished attention. The C.-in-C., the Engineer Adviser at G.H.Q., the Railway Liaison Officer with the French, an Adjutant R.E., a Section Officer, a French Territorial, a civilian and some sappers all took a hand. Noteworthy points about this job are the speed at which the guncotton arrived from "the nearest depot" (which should not be counted on as a precedent); the immense saving in explosive due to the provision of demolition chambers; the time taken to load and tamp—about eight hours; the mechanical failure of the exploder; and the disconcerting behaviour of the safety fuze which burnt through in 30 seconds instead of 1½ minutes. Time spent in testing the exploders and the rate of burning of the safety fuze is seldom wasted.

Page 228, *Bailly.*—The need of cars and lorries for R.E. reconnaissance and working parties 18 years ago is interesting. Warfare has speeded up so much since then that the need of them at the present day can hardly be questioned.

Page 230, *Meaux and Isles les Villenoy*.—The principle here seems to have been that if the responsibility of ordering destruction is allotted to enough individuals there is a chance that the order really will be given by somebody! It sounds easy enough to demolish a bridge "as soon as all troops of the rearguard have crossed." My own limited experience is that every man who comes along claims to be the last, and usually adds (quite cheerfully) the gratuitous information that he is the sole survivor of "A" Company or all that remains of Number 3 Platoon. You wait until he is at a safe distance and prepare to fire your charge, when up come another dozen sole survivors of 3 Platoon! It would be wrong to assume that all, or even most, rearguards behave like that, but it certainly is difficult—especially at night—to decide whether the next dim figure is another "last man" of ours or the first of the enemy.

Page 232, *Iverney*.—The siting of the road block deserves attention as an example of how to do it. It was "where the road narrowed and took a slight turn."

In spite of the ample time that was available for preparing the charges there was a defective joint, which failed. Not being in the electrical circuit it could only be "tested" by inspection.

Page 238, *App. E* (*b*).—Under the present rules if the charges were placed in the opposite angles we should require 44 lb. per girder. 30 lb. was actually used and the demolition was completely successful.

Page 239, *App. F* (*a*).—An example of two kinds of failure. First, the electrical circuit, or possibly the exploder, and secondly the failure of the bridge to drop when the bottom booms only were cut. The introduction of F.I.D.* makes it easier to connect the top and bottom boom charges for firing by safety fuze than it was in 1914.

App. F (*b*) is a very good example of an arch with a deep filling above. The *Manual of Field Engineering*, 1911, made no distinction between a cutting charge placed *on* the arch-ring and one held up against it from below, beyond saying that the former method is the better. *M.E.*, Vol. IV, 1923, lays down that the second method requires considerably more explosive, since the thickness *T* must be taken as the thickness of masonry plus that of the material above it. If this is strictly adhered to a charge below a haunch is almost out of the question. There may well be about eight feet of combined arch-ring and filling and for a bridge 17 feet wide this would require more explosive than a whole Field Company carries.

Actually, at Sempigny they used 230 lb. per charge, which would theoretically cut an arch-ring about 4 ft. 3 in. thick. It would undoubtedly have succeeded if it could have been laid *on* the arch-ring instead of *under* it, and it might have succeeded if it had been under the crown instead of under the haunch. Obviously the intention was to make as wide a gap as possible.

One cannot help feeling that there is really some middle course, such as "T = thickness of arch-ring plus $\frac{1}{2}$ × thickness of filling above," though this is a pure guess. Incidentally the slinging of a charge below the arch is not always an easy matter, especially if there is water below.

* Fuze Instantaneous Detonating.

Page 245, *App. M.*—Le Port bridge is an example of a question that is constantly arising. If the main girders are cut will the subsidiary girders and roadway members hold up or not? It is a gamble. At Le Port there was not time or labour enough to make a clean cut through everything, and although the main girders were completely cut the roadway members held up. They may have been assisted by a certain amount of jamming of the severed girders. What the bridge would carry while in this state is a matter for conjecture; no doubt it took foot-traffic safely, and probably little else. One hopes that it was soon tested with a load that proved too much for it (perhaps a fully loaded staff car).

It is worth noting that in many cases the subsidiary girders are very difficult to get at.

Page 243, *App. L.*—St. Jean-les-deux-Jumeaux. A good example of a charge placed on the arch-ring in a trench dug across the roadway. The width must have been about 15 ft. 6 in., since 31 slabs placed end-to-end reached across it. If T were three feet—a very thick arch-ring—the charge calculated by $\frac{3}{4}$ BT^2 comes to 105 lb. Actually 112 lb. was used. The reason for placing the charge "board downwards" is not apparent. The closer the contact of the explosive with the arch-ring the better. The whole preparation took $4\frac{1}{2}$ hours; the number of men is not stated, but it was probably one section. From the description of the roadway this was a case where a pneumatic road-breaker would be invaluable.

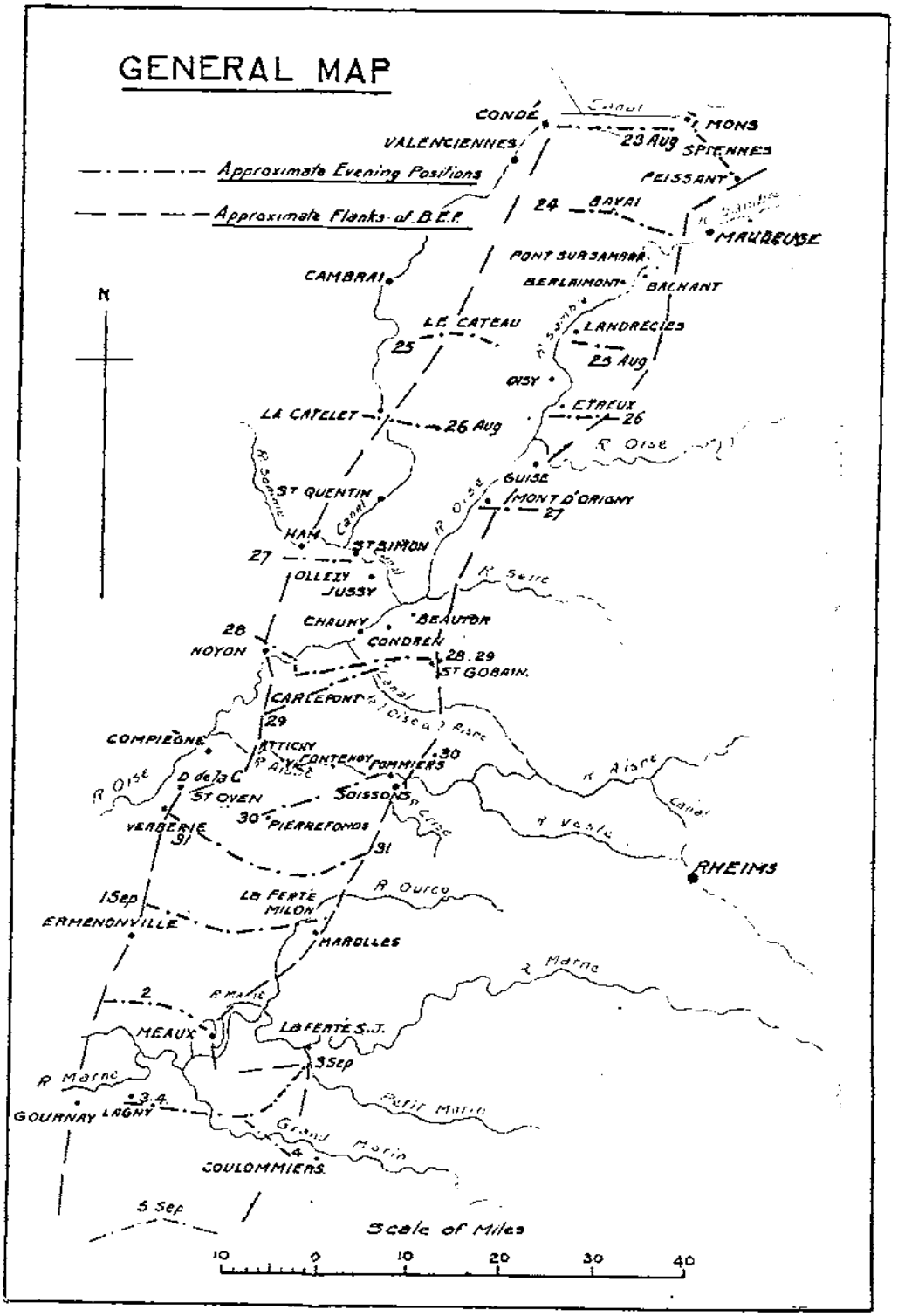
Page 245, *App. N.*—The bridge at Sammeron was very similar. The charge used was practically the same, and the result was even more satisfactory. In this case both of the end arches collapsed when the centre one was cut. Such a result could not be counted on.

Page 246, *App. P* (*a*).—Trilport Road bridge. A very thick arch-ring, and 5 ft. of filling to be dug through.

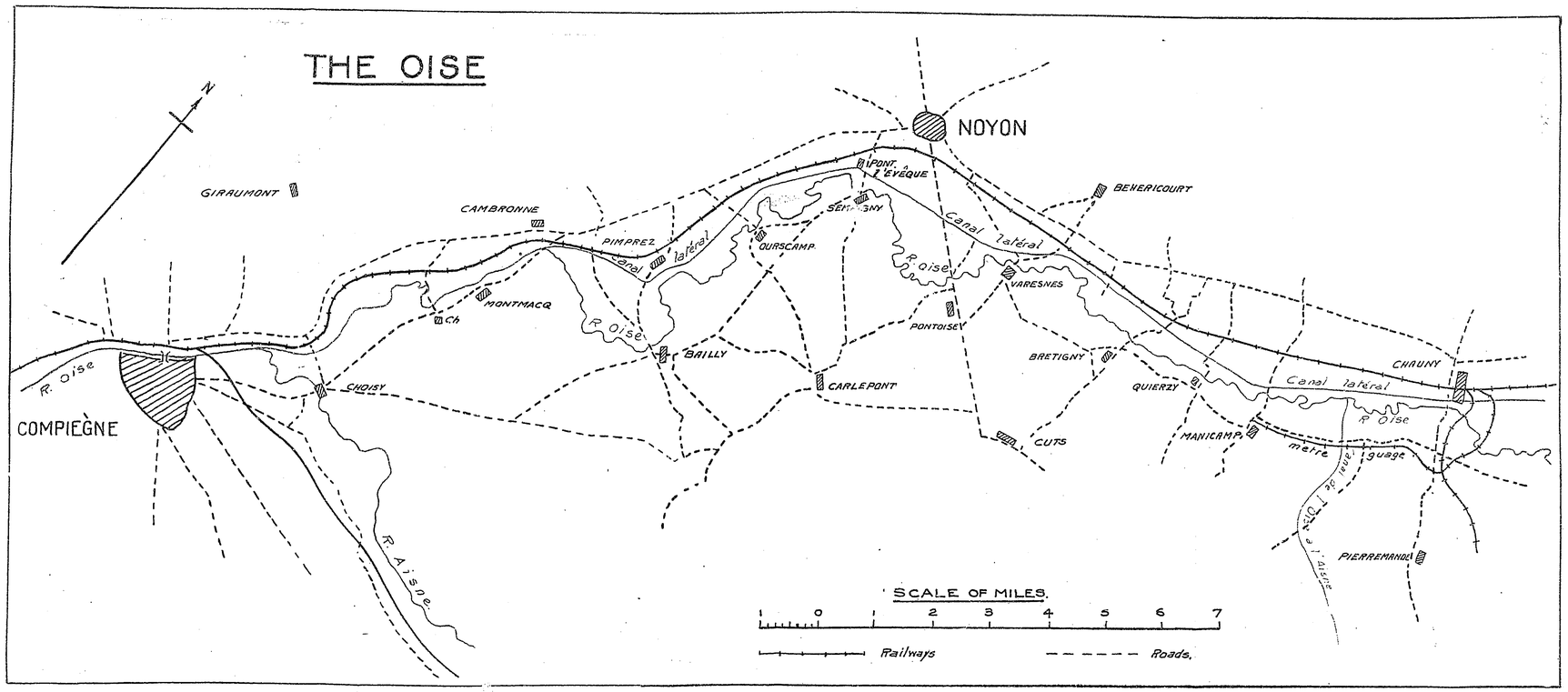
Pneumatic tools would have been useful, but even they require frequent resharpening. Theoretically the charge used is only sufficient for an arch-ring 3 ft. 9 in. thick, but the result was very successful.

App. P (*b*).—Trilport railway bridge.

The chamber extended about 11 ft. parallel to the face, and there were really two separate mined charges. If each consisted of 175 lb. of ammonal D^3 would be $50 \times 175 = 8750$, and D (the diameter of crater produced) would be just over 20 ft. The maximum value for L (the line of least resistance) would be $\frac{D}{2}$ or 10 ft., as compared with 18 ft. as shown on the drawing.


GENERAL MAP
Approximate Evening Positions
Approximate Flanks of B.E.F.
N
CONDÉ
Canal
MONS
23 Aug
VALENCIENNES
SPIENNES
FEISSANT
24
BAVAI
MAUBEUGE
PONT SUR SAMBRE
CAMBRAI
BERLAIMONT
BACHANT
LE CATEAU
25
LANDRECIES
23 Aug
OISY
ETREUX
26
LA CATELET
26 Aug
R Oise
GUISE
ST QUENTIN
MONT D'ORIGNY
27
HAM
ST SIMON
27
OLLEZY
JUSSY
R Serre
CHAUNY
BEAUTOR
28
NOYON
CONDREN
28, 29
ST GOBAIN
CARLEPONT
Canal
29
COMPIEGNE
ATTICHY
CONTENOY
POMMIERS
30
D de la C
ST OYEN
SOISSONS
R Aisne
Canal
VERBERIE
30
PIERREFONDS
31
31
R Vesle
RHEIMS
15 Sep
LA FERTÉ MILON
R Ourcq
ERMENONVILLE
MAROLLES
R Marne
2
MEAUX
LA FERTÉ S. J.
3 Sep
3, 4
GOURNAY
LAGNY
Petit Morin
Grand Morin
4
COULOMMIERS
5 Sep
Scale of Miles
10 0 10 20 30 40

THE OISE


N
NOYON
GIRAUMONT
CAMBRONNE
PIMPREZ
Canal latéral
PONT L'ÉVÊQUE
SEMPIGNY
OURSCAMP
BEVERICOURT
Canal latéral
R. Oise
VARESNES
MONTMACQ
Ch
R. Oise
PONTOISE
BAILLY
BRETIGNY
CHAUNY
R. Oise
COMPIÈGNE
CHOISY
CARLEPONT
QUIERZY
Canal latéral
R. Oise
CUTS
MANICAMP
metre gauge
R. Aisne
PIERREMANDE
SCALE OF MILES.
0 2 3 4 5 6 7
Railways
Roads.

THE MARNE

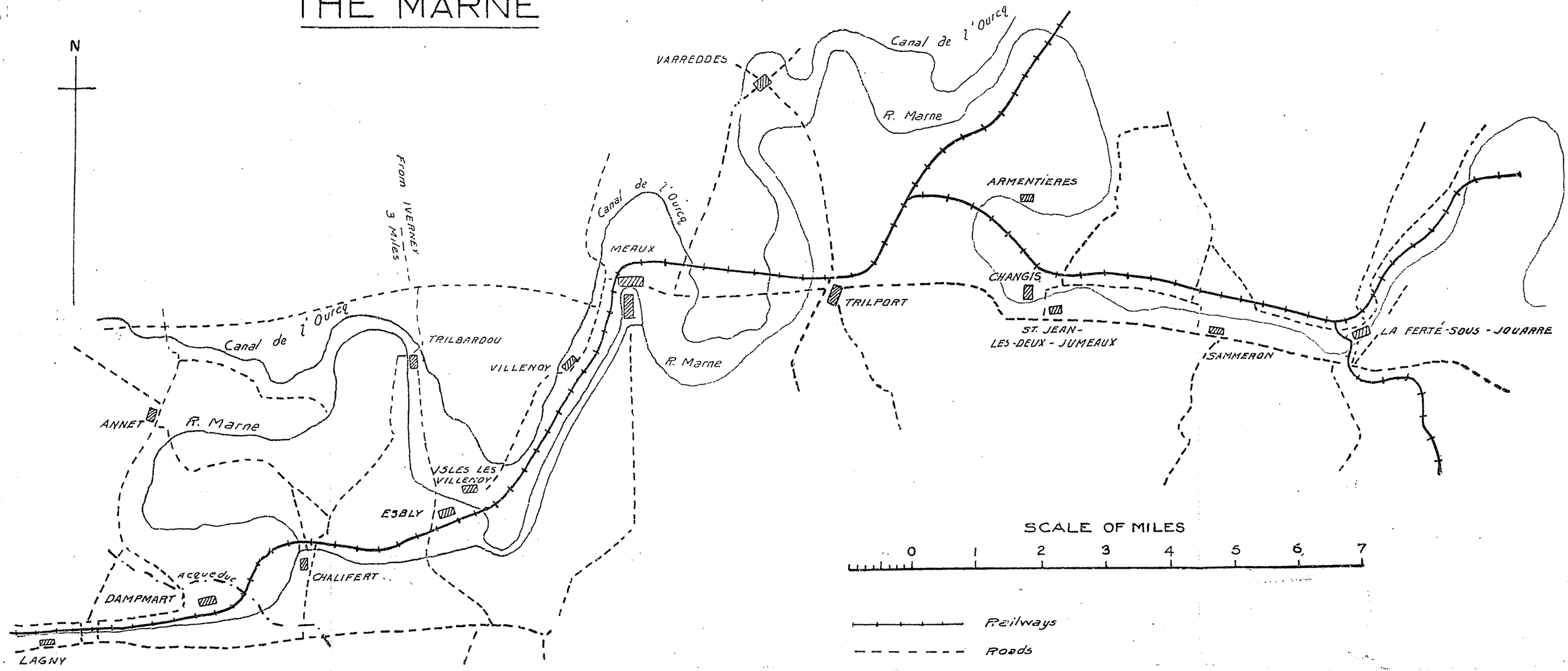
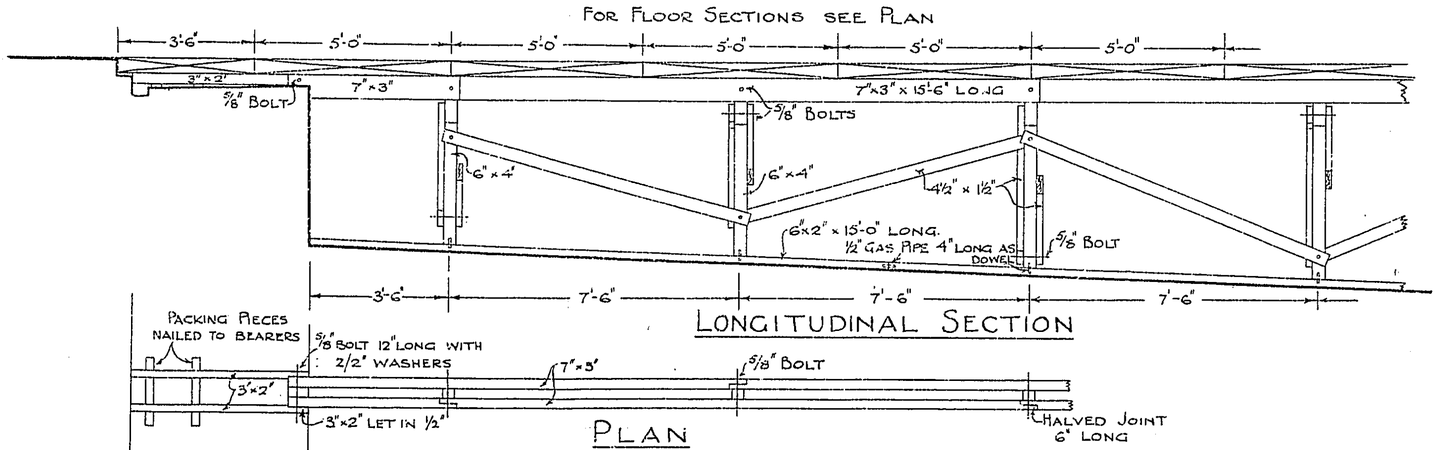

N
VARREDDES
Canal de l'Ourcq
R. Marne
ARMENTIERES
CHANGIS
TRILPORT
ST. JEAN-LES-DEUX-JUMEAUX
SAMMERON
LA FERTÉ-SOUS-JOUARRE
MEAUX
Canal de l'Ourcq
FROM IVERNEY 3 MILES
TRILBARDOU
VILLENOY
R. Marne
ANNET
R. Marne
VSLES LES VILLENOY
ESBLY
CHALIFERT
Aqueduc
DAMPMART
LAGNY
SCALE OF MILES
0 1 2 3 4 5 6 7
Railways
Roads

FIG.3.

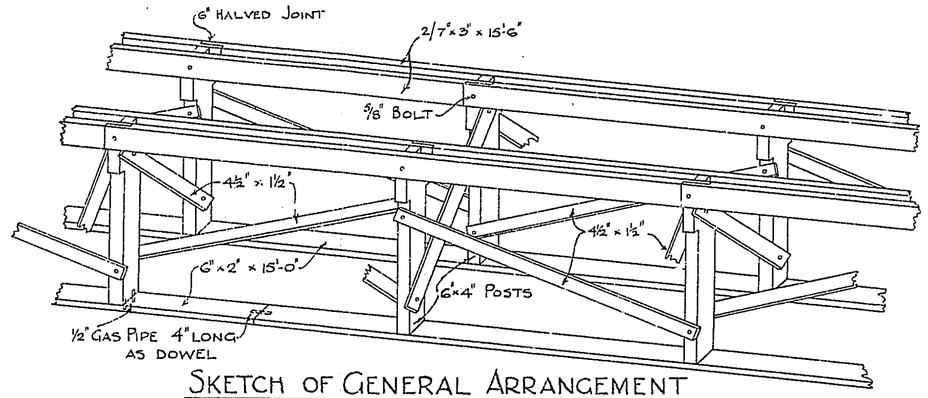
SCALE

INS 12 0 5 10 15 20 25 FEET

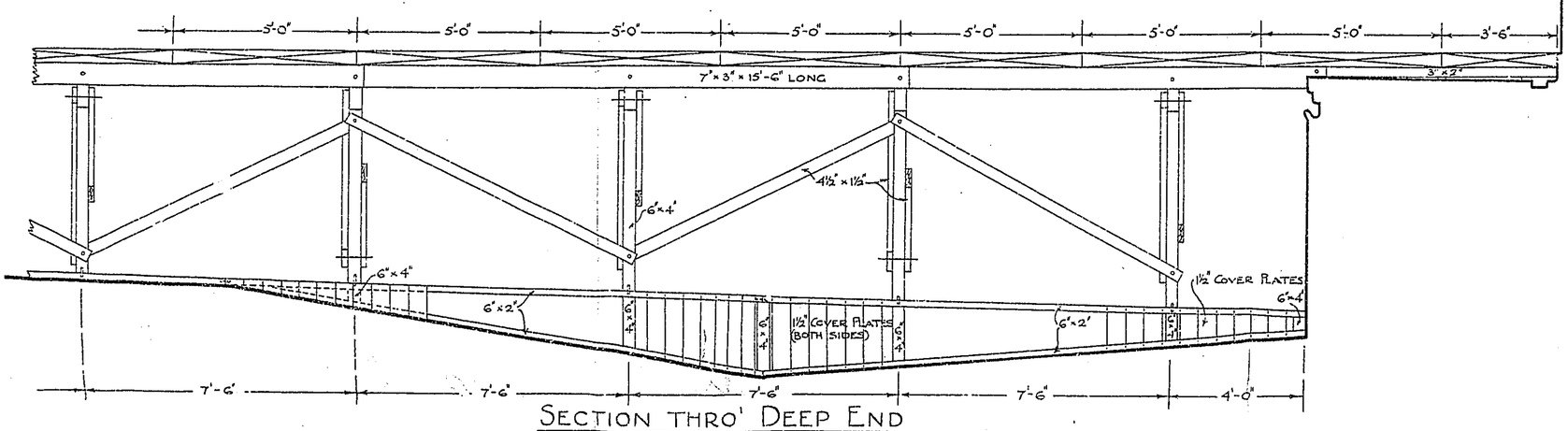


LONGITUDINAL SECTION

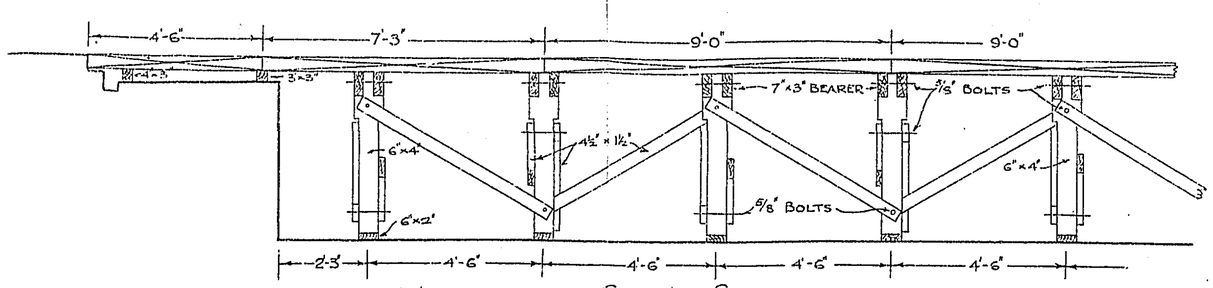
PLAN



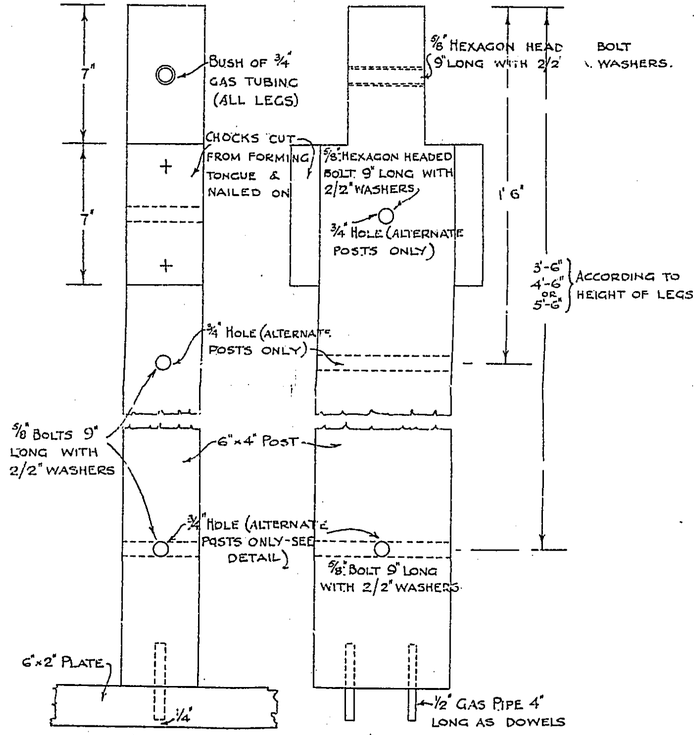
SKETCH OF GENERAL ARRANGEMENT



SECTION THRO' DEEP END

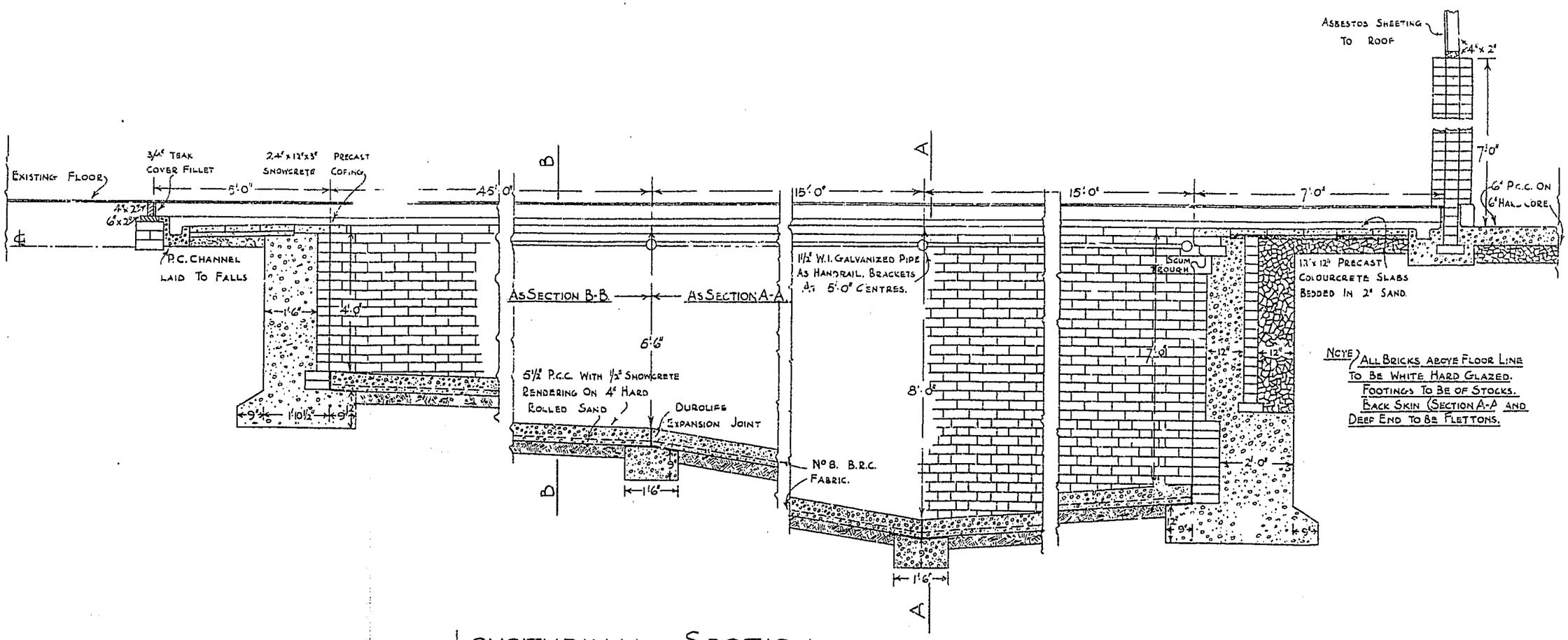


CROSS SECTION



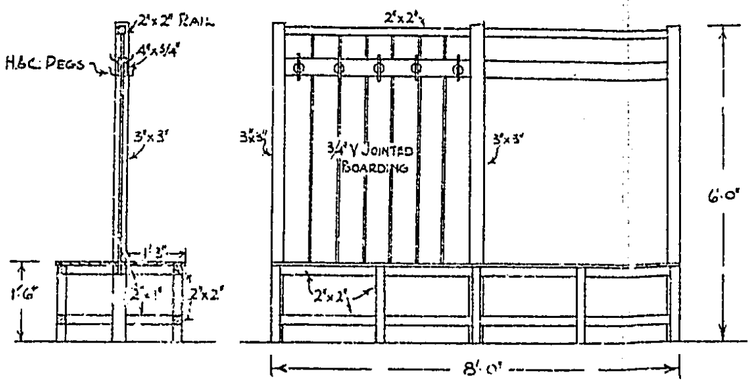
DETAIL OF LEGS

FIG. 2.

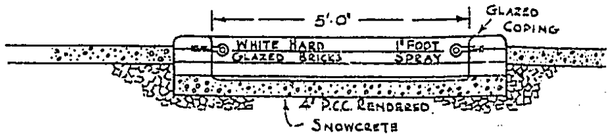


Note) All Bricks Above Floor Line To Be White Hard Glazed. Footings To Be Of Stocks. Back Skin (Section A-A and Deep End To Be Flettons.

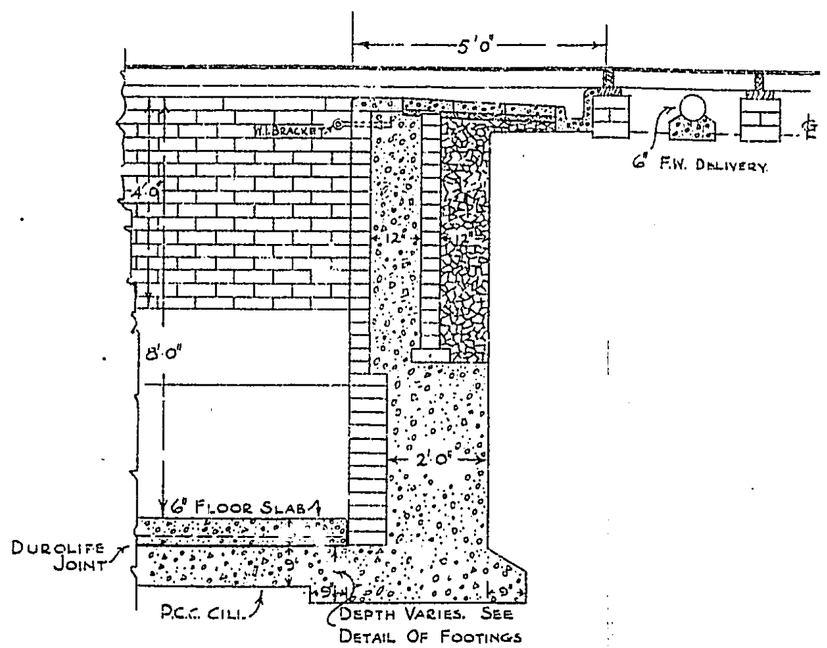
Longitudinal Section.



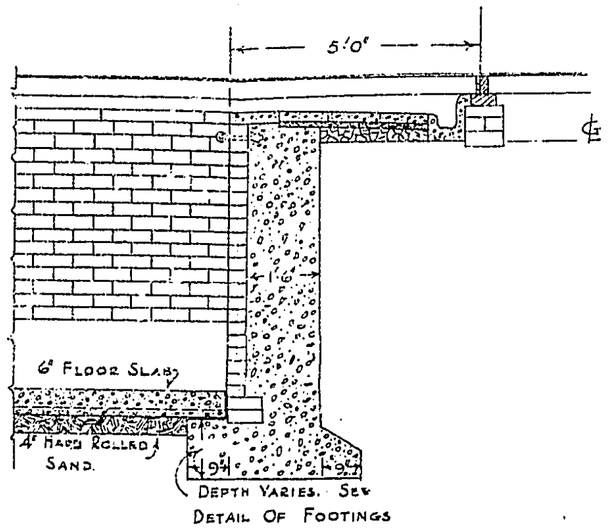
Dressing Room Seats.



Foot Spray And Shower Bath.



Section. A.A.



Section. B.B.

Scale.

Ins. 12 0 5 10 15 20 25 Feet.

FIG.I.

W.C.

UP

CUT NEW OPENING AND REFIX STAPS

5'-0"

DRESSING SPACE

17'-0"

7'0"

5'0"

36'0"

OUTLET

6" P.W. DELIVERY

12"×12"×2" PRE-CAST COLOURCRETE SLABS

24"×12"×3" PRE-CAST SNOWCRETE COPING

2" SPRAY INLET PIPE

1½" G.I. PIPE AS HANDRAIL

75'-0"

15'-0"

15'-0"

6" OUTLET

CHEMICAL POTS

REFLUX VALVE IN PIT

SCUM TROUGH

3" WASTE FROM SCUM TROUGH TO WASH WATER SUMP

CHLORINATING APPARATUS

BOILER

STEAM INJECTOR

AERATOR

COAL 1,000 GALLON TANK OVER FOR WASHING FILTER

AIR SUCTION

STEAM

FILTER

AIR

STEAM JET AIR INJECTOR

WASH WATER SUMP UNDER

STRAINER

PUMP AND MOTOR

A

9'0"

ENTRANCE

12'0"

OUTLET

5'0"

7'0"

6" P.C.C.

LAID TO FALL

OUTLET

WASH BASIN

6'6"

FOOT SPRAYS

SHOWERS

9'3"

FOOT AND SHOWER BATHS

OUTLET

W.C.

A

INCHES R. O. 5 10 15 20 25 30 FEET.

SCALE.

HANGER

H.C. SUPPLY

SHOWER

ASBESTOS SHEETING

DRESSING ROOM LEVEL

7'0"

4" P.C.C.

GLAZED BRICKS

1" FOOT SPRAY

1" R.C.C. RENDERED SNOWCRETE

G.L.

SEE DETAILS

12"

6" P.C.C. RENDERED SNOWCRETE

4" HARD ROLLED SAND

4'6"

7'0"

SEE DETAILS

6" OUTLET

7'0"

6" P.C.C. ON DRY FILLING

3" WASTE TO WASH WATER SUMP

SECTION A.A.

THIS TANK BUSINESS—IN FACT AND FANCY.

By COLONEL M. N. MACLEOD, D.S.O., M.C.

"WHEN we look back on the history of war," writes General Fuller, "what do we see? A school of pedants, fumbling with the past, hoodwinked against the future, seeking panaceas from past victories, the circumstances under which they were won being blindly accepted as recurring decimals. . . ."*

In 1918 was won one of the greatest of all "past victories": it is now part of that history of war in which the seekers of panaceas are always busy. There are some who claim to have found one.

"It was not the genius of Marshal Foch which defeated us," writes General von Zwehl, "it was 'General Tank.'"

In his book, *The Reformation of War*,† General Fuller quotes this statement and adds, "I do not intend here to prove this assertion, for it has already been proved in many books." He continues: "On November 20th, at the battle of Cambrai, tradition received such a blow between the eyes that even the most pessimistic asserted that the tank had at length come into its own."

Should any R.E. officers feel disposed to join the "school of pedants," here are a few facts on which they might start their fumblings. They may provisionally agree with General Fuller that it was on November 20th, at Cambrai, that tradition received its greatest "blow between the eyes," but before they accept his or General von Zwehl's panaceas, it is as well that they should realize that the novel feature about this remarkable attack was not that it was led by 380 or so new tanks, but that a new method of handling the artillery was there tried for the first time.

The manner in which the opening artillery bombardment at this battle was organized was a far greater break with tradition than the use of tanks. Tradition had already received its blows from the tanks more than twelve months before. The first, as is well known, was delivered at the battle of the Somme, on 15th September, 1916; it made so little impression that, as we now know, Earl Haig asked for work on the tanks to be stopped. The next blow was delivered at Arras, where the tanks detailed to assist the Canadians failed to arrive, but nevertheless—quoting General Fuller's own words—"The Canadians . . . took the Vimy Heights almost at a rush . . . the rapidity of the advance due to the excellent work of our artillery, and the dash of the Canadians, rendered the co-operation of tanks needless."‡

* *Tanks in the Great War*, by Colonel J. F. C. Fuller, page 297.
† Page 115. ‡ From *Tanks in the Great War*.

Following this came a knock at Bullecourt: selected for attack because the ground was favourable to tanks, but where, nevertheless, success was still denied them.

Yet another blow was delivered at Messines, where 76 tanks took part in the attack. General Fuller tells us, however, that "Messines was in no sense a tank battle, though a notably successful one." Later on, in 1917, tradition got a final punch at Ypres, where, under appalling conditions, the tanks were a complete failure.

Reverting, however, to November 20th, 1917, earnest seekers of panaceas may suggest that if General von Zwehl is unbiased and to be relied on, and is not only trying to maintain the prestige of the German Generals' Union by putting up a smoke screen across the true facts, he or someone else should explain why it was that, after the initial and completely successful attack on November 20th, the British, despite the continued use of tanks, were held up by a very hastily reorganized German defence. He might go farther and explain how it was that the German counter-attack, delivered a few days later, although unsupported by any tanks, was very nearly as successful as the initial British effort.

We know, of course, that the Germans were taken completely by surprise by the initial British attack—as were the British by the German counter-attack—although the British had anticipated a counter-attack exactly where it arrived. But this alone is hardly enough to explain why the panacea worked so well against the concrete pill-boxes and acres of intact wire of the Hindenburg Line, yet apparently failed as soon as all these formidable defences had been passed. Surely it ought to have worked still better.

A great deal has been written about the tanks at Cambrai, but unfortunately not very much about the artillery bombardment, which was, as has been stated above, the real novelty in this epoch-making battle.

In his dispatch describing the battle, Earl Haig wrote: "No previous registration of guns . . . could be permitted as it would have roused the enemy's suspicions. The artillery of our new armies was necessarily subjected to a severe test in this operation and proved itself entirely worthy of the confidence placed in it." Why did Earl Haig write this when the difference between this and all previous bombardments was entirely due to the work of the Royal Engineers? Presumably he did not know that the "severe test" in this bombardment was not of the artillery, but of the 3rd Field Survey Battalion, R.E., who had to fix the positions and lay out lines of fire for every single reinforcing battery. The work of the artillery, who were allowed to do no shooting before the event, was undoubtedly simpler than at any previous battle. This is proved—if proof is necessary—by the very much shorter time required to concentrate the guns and organize the bombardment, as compared with previous occasions.

Cambrai, however, though it may have been the first, was not the only successful attack in the Great War; seekers of panaceas will be wise not to confine their "fumblings" to that one battle. On March 21st, 1918, the Germans had their turn. Here the panacea could not have been "General Tank," for he was fighting on the other side: nor was there any considerable surprise to account for the break-through. General Gough has been at some pains to explain how much he knew about the attack before it took place. Although the British were expecting the attack, they had had no previous experience of the Cambrai type of bombardment. They were now to get it and the sequel is of interest.

The main German attack was that of von Below in the north: the attack of von Hutier, which actually effected the break-through, was really a subsidiary. We now know that von Hutier's army based its artillery bombardment on methods similar to those used by us at Cambrai, while von Below's preferred to stick to tradition.

Is it a coincidence that it was von Hutier and not von Below who broke through?

We now know also that on the German side of the line these particular methods were the stock-in-trade of one, Major Bruchmuller, and that they earned for this gentleman the nickname of "*Durchbruchmuller*"—"Break-throughwallah," in the British vernacular. Is this a coincidence, too?

Let us, however, return to our own side of the line. On August 8th, 1918, our turn came again and we repeated Cambrai on a larger scale. Again all the reinforcing artillery had to depend on the Field Survey Battalion, R.E., for its bombardment data.* Again the same remarkable successes—with even greater captures of prisoners and guns—and more remarkable still, again the same failure of the panacea after the German line had been broken through and his troops thrown into confusion.

On the previous occasion at Cambrai the failure was explained by the exhaustion of the tank crews. This time it was ascribed mainly to the arrival on unfavourable ground, for the old trench systems "offered exceptional facilities for defence."

The tanks were accordingly given a "busman's" holiday and moved off to another sector, where *mirabile dictu* the panacea worked again. The attack of the 3rd Army, supported by tanks, refreshed and reinvigorated by their journey from the scene of the late battle, *as well as by a similar type of artillery bombardment*, again overthrew the German defences and pressed forward towards Bapaume.

Truly a curious panacea this. One which seems to work best against well-organized defences, for the advance of the 3rd Army is before long brought to a halt also and the offensive renewed elsewhere. Let us pass on quickly, for again Earl Haig has changed the scene

* See page 26, *The Story of the 4th Army*.

of battle. The 4th Army is attacking once more: the Australians have stormed Mont St. Quentin and are pressing forward to the Hindenburg Line. On September 18th, two Australian divisions are detailed to attack the old British trench line: only nine tanks are available to assist them and some of these arrive late; the panacea, in fact, has to be left behind. However, the artillery is there in full force and once more goes through its new trick. The two divisions do not do so badly. Here is an account of the action: "The infantry advanced to the attack at zero, keeping close behind the barrage, which was excellent and so dense that the enemy in many cases went to ground and became an easy prey."* On this occasion these two divisions sent 6,000 men into battle, and at the price of 1,012 casualties they captured 165 officers and 4,078 German other ranks.

The scene again changes, attack follows attack. Some make use of the panacea and others do not; without it the 46th Division succeed in storming the St. Quentin Canal and King Albert breaks through at Ypres. But tanks or no tanks, all the great attacks are supported by bombardments modelled on that of Cambrai: without exception, all succeed.

Some of the minor attacks, however, are not so supported, nor are they always so uniformly successful. Colonel Martel tells us in his book, *In the Wake of the Tank*,† that "on occasions we attacked without suitable artillery support or without a well-co-ordinated plan and these (attacks) were almost invariably failures." Seekers of panaceas will note that Colonel Martel is not one to depreciate unduly the services of the tanks. They will also do well to compare and contrast this persistent success of all the British attacks in 1918 with the results of the German offensives of the same year. The initial successes of the German attacks were, with one exception, quite as spectacular as anything achieved by the Allies, but in contrast with the British attacks their offensives seem to fade away badly afterwards. The Germans have been blamed for transferring their offensive from point to point, thus contravening the principle of the maintenance of the objective, even though for a time each new attack seemed more successful than the last; yet this is exactly what the British did, and apparently with advantage. What is the explanation of this paradox?

Referring to the German offensive of March, 1918, the Editor of *The Fighting Forces* writes: "The terrific bombardment fell with greatest force on the front line. Incidentally, it was interesting to note the amazing difference between the opening bombardment and subsequent artillery action." Can it be that the Germans in their haste to snatch a victory—and following tradition—left behind them

* From *The Story of the 4th Army*. † Page 35.

their artillery, which was the instrument of it, and tried to win it with infantry and machine-guns alone?

What advantage did the British gain by their moves which the Germans failed to take? If it was an advantage for their tanks we cannot explain it, for although the tanks helped the British to make their changes of sector quickly, the change itself can hardly have been of any help to them. If we look, however, to the artillery, there is no difficulty; this change of sector was the only way in which the necessary superiority in guns and ammunition could be assured —only thus could time be gained for the necessary preliminaries and only thus could targets be fixed for the guns: only thus, in short, could artillery protection be assured for the infantry and the tanks, and when the latter outran it, the advance stopped.

One further example of the panacea in action and without artillery assistance may be given. On October 23rd, a night attack (in bright moonlight) was delivered at Catillon, supported by a considerable number of tanks. "The day on the whole was not a happy one for the tanks. Owing to the indifferent light in the early stages of the attack, a large number were ditched in passing over comparatively insignificant obstacles,"* and here, to compare with it, is an account of another almost contemporary action in which the panacea was left at home. "At 5.15 a.m. on November 1st, the attack was launched and from the first went entirely according to plan . . . the enemy barrage dropped quickly and was very heavy, but shortly afterwards slackened down under the influence of our efficient counter-battery fire. In the meantime the attacking infantry got well away, advancing under a most excellent barrage and reached their objective, the line of the Valenciennes–Mauberge railway on time, right behind the barrage. The fighting during the advance was heavy, especially around the houses along the Farmas–Valenciennes Road and in Aulnoy. The thoroughness of the preparations made for this small but important battle is better illustrated by the following striking figures:

> Number of enemy dead buried: over 800.
> Prisoners captured (exceeding the number of the assaulting troops): over 1,300.
> Our casualties (approx.): 80 killed and 300 wounded."†

All these facts—and they are facts, most of them easily verified—without in the least degree minimizing the very great services rendered by the tanks, point to a very different conclusion from that drawn by Generals von Zwehl and Fuller. It still remains, however, to consider the "circumstances under which these victories were won." We may take a glance at them. This is how General Fuller

* From *The Story of the 4th Army*.
† *Interim Report, Canadian Corps Operations during* 1918, by General Sir A. W. Currie.

describes them: "In general the keynote of the German anti-tank defence was lack of foresight . . . the German General Staff lacked imagination and the faculty of appreciating the value of weapons that had not been explained to them at school. . . . From September, 1916, onwards, to the conclusion of the War, German anti-tank tactics passed through three phases: firstly, the enemy had no anti-tank defence at all . . . secondly, having learnt but little about tanks, he considered that only small expenditure of effort and material was required to deal with weapons of so limited a scope. Thirdly, from August, 1918, he took panic and overestimated their powers."

Virtually the only special anti-tank weapon used by the Germans was the heavy anti-tank rifle, and of this General Fuller writes: "It was too conspicuous and too slow a weapon to be really effective against tanks, though it could easily penetrate them at several hundred yards' range. Its chief disadvantage was that the German soldier would not use it. . . . It is doubtful if one per cent. of the anti-tank rifles captured in our tank attacks had ever been fired at all." Under these circumstances it is not difficult to see why von Zwehl said that it was "General Tank" who won the last war, but unless he is "blindly accepting" these circumstances "as recurring decimals," it is less easy to see why General Fuller thinks the same "General" will win the next one. Actually this is what General Fuller thinks.

"In the van of the battle of the future may we watch the scout tanks, the light cavalry of the army, retiring before the side which has gained the initiative, falling back on their heavier machines or away from them to a flank, to draw the enemy into a false position. Wireless reports will be sent back from the air fleet and telephoned from the flag tank to the squadron leaders, who will manœuvre for ground, for position, for light and for wind. Great clouds of smoke will roll over the battlefield, under cover of which mine-laying tanks will move forward to deny to the enemy's machines certain tactical positions, or in the hope that, by a calculated retirement, they may be induced to advance across them. Destroyer tanks will dart forward to attack the huge artillery machines, the capital ships of the battlefield, and succeed or be driven back by their like. Then at length will the two sides clinch and, amidst the whirl of smoke and gas, the thunder of the guns and the crash of steel, will one human being impose the will of his army on that of his antagonist.

"The battles of the future will be something like this . . . we are entering a new epoch of warfare . . . in it infantry, cavalry, artillery, as they are armed, mounted or moved to-day, have no place—NONE."*

This, of course, is straying into fancy and we have been dealing only with facts. For the benefit of those "fumblers" who prefer

* *Reformation of War*, p. 167.

the obvious interpretation of these facts to that of General von Zwehl, here is one last and hitherto unpublished fact which they may be interested to include in their survey.

Whatever opinions may be held on the performances of "General Tank," the value of the system of bombardment initiated at Cambrai is not in doubt; the mere fact that it was repeated on every subsequent offensive establishes its value beyond dispute. It was this system which enabled Earl Haig, in 1918, to transfer the weight of his offensive from one sector to another, with a speed which would have been quite impracticable the previous year. Bright luminaries in the artillery firmament have since been heard to refer to it as the greatest advance in artillery tactics since the introduction of gunpowder.

Now this system was initiated by, and based on the work of, the Field Survey Battalions, R.E. R.E. Survey personnel did all the essential preliminary work, and some, if not all, of the Field Survey Battalions ran courses of instruction to teach R.A. officers how to use the data supplied. Yet although the Field Survey Battalions were singled out for special mention in Earl Haig's dispatches dealing with the fighting of 1916 and 1917, *i.e., before these methods were brought into use,* in those later dispatches which deal with Cambrai and the battles of 1918, the one mention of these units is incidental only: it gives their title incorrectly, and commends them for work which, though important, had nothing whatever to do with this particular matter. Surely this is a very remarkable omission.

Anyone familiar with the British "Order of Battle" during the Great War will, of course, have no difficulty in accounting for it: the Field Survey Battalions formed part of the Corps of Royal Engineers and were not under the orders of the artillery commanders. It was not the business of the latter to bring to the notice of Earl Haig officially any services rendered by units not serving under them. It would have been definitely "out of order" and a contravention of regulations for them to do so. Nor were these units, although Royal Engineers, under the orders of the Chief Engineer. They were under the orders of the Intelligence Branch of the General Staff and officially the Intelligence Branch were not concerned with events which took place on their own side of the front line. As a result of this combination of circumstances the exact nature of the blow given to tradition at Cambrai seems to be in some danger of being overlooked. Historians and critics who have not the same excuses as contemporary dispatch-writers have, at any rate, hitherto failed to notice it and their failure seems to have been not without effect on military thought. They might do well to look into the matter.

HISTORY OF THE 7th FIELD COMPANY, R.E., DURING THE WAR 1914–1918.

With a short Record of the Movements and Campaigns since the Formation of the Company.

By CAPTAIN H. A. BAKER, M.C., R.E.

(*Continued.*)

CHAPTER III.

THE GREAT WAR.

MOBILIZATION AND THE RETREAT FROM MONS.

Maps II and III.

MOBILIZATION was ordered on August 4th, 1914, and was completed by the 9th except for horses.

After a week's training the Company joined the 4th Division at Stanmore, near Harrow, and embarked for overseas on August 22nd, arriving at Havre the same day and proceeded to Rouen on the 23rd. The strength on arrival in France was 6 officers and 271 other ranks, Major S. G. Faber in command.

After various abortive train journeys the Company was detrained at Noyon on the 27th August, and from this date took an active part in the retreat from Le Cateau.

Demolition of Bridges over River Oise.

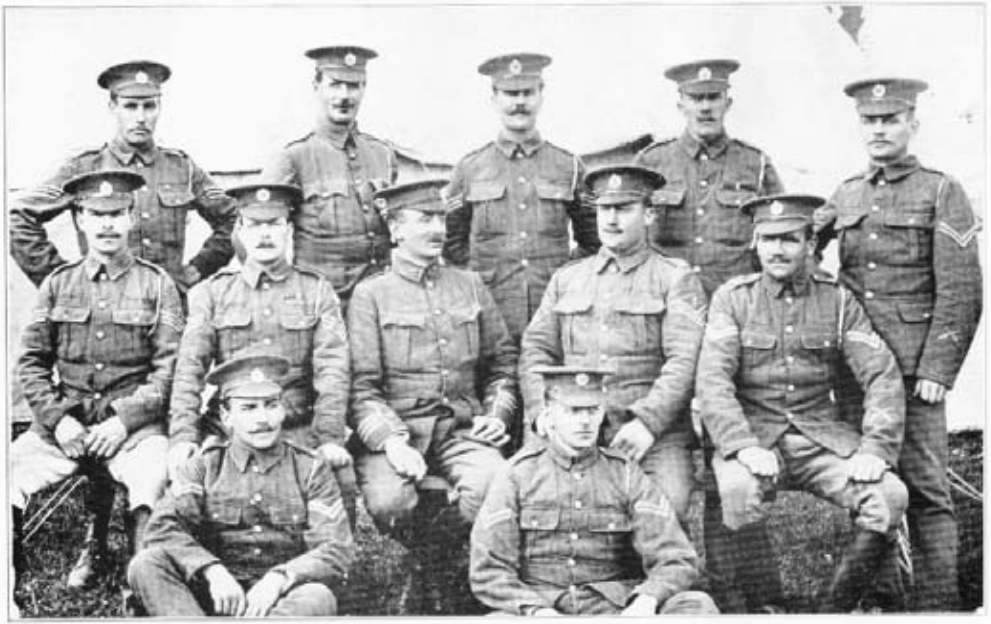
Orders were received about mid-day 29th August to prepare three bridges for demolition—two over the canal and one over the River Oise between Pont d'Evêque and Sempigny.

The work was completed under Lieut. G. N. Macready early on the 29th, demolition being effected successfully on the 30th. During the demolition of the last bridge Lieut. K. I. Gourlay and party were fired on by Uhlans who had crossed into Sempigny through our cavalry screen; two sappers being severely wounded. The party, after completing its task, managed to get away on bicycles and on horses of the Lancers.

The retreat continued for six days and nights. The marches, carried out for the most part in contact with the enemy, averaged sixteen miles a day and allowed of little rest at night. The Company's diary was as follows:—

31st to Verberie (26 m.). 13 hours on march.

1st September. Baron (12 m.). At dawn on this day the 11th



Back Row.—Attd. from T.F., Serjt. Johnson, Serjt. Hanley, Corpl. Drake, Corpl. Law.
Second Row.—Serjt. F. Armstrong, C.Q.M.S. Knott, Major S. G. Faber, O.C., Serjt. A/C.S.M. Wren, Corpl. Ingleton.
Front Row.—Corpl. D. Yates, Corpl.

GROUP AT SHORNCLIFFE IN 1914.

Group at Shorncliffe in 1914

Group of 7th Field Company N.C.O.s and Officers taken early 1915 or late 1914 at Pont de Nieppe.

Back Row.—C.Q.M.S. W. Knott, Sjt. J. Johnson, Cpl. Burrows, Cpl. McCoubry, Cpl. A. Law, Sjt. F. Armstrong, Sjt. T. Hanley, Mons. Rimbaud (intr.), Sjt. H. Russell, Cpl. D. Yates, Cpl. H. Lauder, Cpl. G. Church, Cpl. A. Chase.

Group of 7 Fd Coy NCOs & Offrs 1915 Pont de Nieppe.

Brigade and the Company were " surprised " in billets by parties of Uhlans, the Brigade suffering casualties. The 7th Company sentry shot one of the enemy. During the march the Company put Chamicy in a state of defence.

2nd September. Dammartin (11 m.), where work was carried out on water supply.

3rd September. Chanteloup (18 m.). Major Faber became a casualty through sickness and the command devolved on Capt. V. P. Smith.

4th/5th September. Brie-Comte-Robert (16 m.). On this day —" the last day of the retreat " *vide Brit. Off. Hist.*—the Company was again marching north-eastwards.

These seven days of incessant marching and work, followed by a further eight such days during the advance to the Aisne, with no real rest, were a severe test of endurance and march discipline, especially for a unit containing a high proportion of recently-joined reservists. During these marches sickness casualties were few, but towards the end of September they amounted to 1 officer and 20 other ranks as a result of the fatigue, strain and exposure of these early weeks. Heat followed by much rain contributed to make conditions particularly trying. Other casualties by the end of September amounted to 5 other ranks wounded or missing.

THE BATTLE OF THE MARNE AND THE ADVANCE TO THE AISNE.

Map III.

The 4th Division now formed part of the III. Corps and was on the left wing of the British Army during its advance across the River Marne to the River Aisne.

The following is a summary of the Company's movements and work during these operations :—

7th September to Les Corbiers (7 m.), immediately south of La Ferté on the River Marne.

9th September. Bridging the River Marne. The bridges at La Ferté had been destroyed. From reconnaissances made by the C.R.E. (Lieut.-Colonel H. B. Jones) it was decided to bridge at La Ferté, just below the destroyed masonry bridge. The 9th Company was able to get down to the bridge site at 4 p.m. and commenced to collect materials and make barrel piers. A bridge of 220 feet span (2 trestles, 4 pontoons, 4 barrel piers, 1 barge, 2 boats) was completed by 7 a.m. on the 10th September, the 9th Company working on the bridge and the 7th Company on the approaches. Covering troops were ferried across in boats.

10th September. The passage of the 11th and 12th Brigades with transport and of a French cavalry brigade commenced early and continued till 8.30 p.m.

11th September. The 7th Company dismantled the bridge at

4.15 a.m. and marched *via* Montigny to St. Quentin (16 m.). Wet weather prevailed and the roads were bad.

12th September. To Tigny (17 m.). On this day the British advanced troops reached the River Aisne.

13th September. Bridging the River Aisne. The Company marched from Tigny at 3.30 a.m. to Billy (8 m.). A site for a bridge over the River Aisne having been reconnoitred by the C.E. (Major-General F. M. Glubb, C.B.), accompanied by the C.R.E. 4th Division, it was decided to bridge at Venizel. The 7th and 9th Companies reached Venizel at 10.30 a.m. for combined work. This was delayed by shelling, but commenced at 12 noon. A bridge of 195 feet span (3 trestles, 4 pontoons, 5 barrel piers) was completed by 6 p.m. At 3.30 p.m. the 7th Company was dispatched to Soissons (4 m. east of Venizel) with a view to joining the 2nd Bridging Train and constructing a heavy bridge at Soissons at a site reconnoitred by Capt. V. P. Smith.

14th September. An attempt to make heavy bridge at Soissons was frustrated by heavy shell fire and, on the French taking over this area, the Company was withdrawn at 1 p.m. to Vignoles (2 m. south of Soissons) and came again under the 4th Division.

OPERATIONS ON THE RIVER AISNE (15TH SEPTEMBER TO 5TH OCTOBER, 1914).

Map III.

The rapid retreat of the German Army to the Aisne after its defeat at the battle of the Marne (8th to 9th September) was followed by the battle of the Aisne (12th to 16th September), by which latter date the allied advance was definitely checked and trench warfare on an extensive scale developed.

On the 15th September the Company returned to Venizel. No. 1 Section took charge of the floating bridge there, the remaining sections being allotted severally to the three brigades of the 4th Division, all of which were in the line. These sections worked from Ste. Marguerite, 3 m. north-east of Venizel and ½ m. in rear of the advanced trenches. Most of the work was carried out after dark and consisted mainly of constructing wire entanglements (the wire being collected from fences), overhead cover, trip wires, clearances, shelters and work on communications generally. Work was also carried out on a defensive position south of the River Aisne.

On the 21st, Capt. C. B. O. Symons took over command of the Company.

The British Official History (Vol. I, p. 383), after recording the number of bridges over the River Aisne constructed during this period on the British front, reads: "This bald enumeration, however, gives but a slight idea of the strain borne by the Engineers during the weeks that the Army was on the Aisne. Nearly all of the

bridges were within known range of the German guns ; most of them were constructed and all of them repaired under fire. Yet the Engineers contrived not only to maintain the bridges but to make bridgeheads and to entrench positions against possibility of retreat. In the course of the operations on the Aisne the divisional Field Companies, R.E., which had done the work, were reinforced by the Bridging Train and by two Fortress Companies from the L.-of-C. : but even with this assistance the burden of the work thrown on them was enormous."

MOVE FROM THE AISNE TO FLANDERS (6TH TO 18TH OCTOBER, 1914).

Map II.

On the 15th September began the extension northwards of the French Army in the "race to the sea." The transfer of the B.E.F. from the Aisne to Flanders took place between the 3rd and 12th October. The III. Corps handed over its trenches to the French on the night of the 6th October and entrained near Compiègne on the 7th/8th, for concentration about St. Omer and Hazebrouck, whence it moved on the left rear of the II. Corps to Bailleul. The whole movement was carried out with secrecy and mainly by night.

The 7th Company detrained at Blendecques (3 m. south of St. Omer) on the evening of the 12th, and marched to Hondeghem (13 m.), moving on the morning of the 13th in rear of the 11th Brigade to 1 m. east of Caestre. During the afternoon the 4th Division drove the German cavalry and cyclists from a position running north and south through Meteren, at which village the Company billeted for the night, its bridging equipment having been parked with that of the 9th Company at Caestre. Owing to the numerous dykes intersecting the country each trestle wagon was loaded to carry five bays of superstructure. The night of the 14th was spent at Bailleul.

During the night 15th/16th Nos. 3 and 4 Sections marched to Nieppe and assisted the Somerset Light Infantry in putting that place in a state of defence. Capt. Symons and Lieut. R. G. Wright proceeded to reconnoitre the bridges over the River Lys at Erquinghem which were found to be held by the enemy. At daybreak on the 16th, Capt. Symons again reconnoitred and was able to cross the bridge at Erquinghem which, however, was subsequently re-occupied by the enemy. On the same day Nos. 1 and 2 Sections moved up from Bailleul and joined the 12th Brigade at Ploegsteert, where they assisted the Inniskilling Fusiliers to strengthen their position east of that village. Nos. 3 and 4 Sections proceeded with the 9th Company to Armentières and Houplines and carried out bridge repairs. The Division moved forward to the line Le Gheer–Houplines–Armentières.

On the night of the 17th Nos. 3 and 4 Sections carried out entrench-

ments near Le Gheer. On the 18th, Company headquarters and these two sections were established at Le Bizet, where the former remained till 14th December.

The village of Le Touquet was attacked by the 11th Brigade on the 18th and 19th October, and Nos. 3 and 4 Sections constructed barricades by night in the captured village.

Between 24th and 29th, section commanders supervised civilian labour working on second line trenches by day. Sections worked on barbed wire, etc., in the front line by night.

Reinforcements now received brought the Company to strength 6 officers and 193 other ranks.

PLOEGSTEERT (19TH OCTOBER, 1914, TO 13TH FEBRUARY, 1915).

The Company now settled down to a lengthy period in the Ploegsteert–Armentières area.

This proved a very strenuous time for the Engineers, on whom devolved in great measure the task of constructing and maintaining the forward infantry defences, with the help of infantry working parties, including entrenching, revetting, wiring, drainage, trench-boards, shelters, as well as work on second line defences under divisional control, and hutting, water supply, etc., in back areas.

The winter was very wet and the position very flat and low-lying. The demands on engineers for stores was immense and the saw mills in Armentières were a great boon to the Company, who were soon turning out some two miles of scantlings daily.

During November and December a timber girder bridge was constructed over the canal at Armentières. Central span 65 feet —total span 122 feet.

On the 2nd December Nos. 3 and 4 Sections paraded with other units at Nieppe for inspection by H.M. The King, when Serjt. Johnson received the Distinguished Conduct Medal.

Total casualties during the months October, 1914, to February, 1915, amounted to 3 killed and 7 wounded—numerically slight casualties in view of the nature of the work.

ARMENTIÈRES (13TH FEBRUARY TO 28TH APRIL, 1915).

Headquarters and Nos. 1 and 4 Sections moved on the 13th February to billets in Armentières, and remained there till early in May when they rejoined the other two sections at Ploegsteert.

Mining was commenced in March in reply to that of the enemy. Two detachments of miners were formed from the Monmouths, R.E. and S. Lancs Regiments and worked under the direction of O.C. 7th Company. On the 9th April a mine was successfully fired at the railway barricade, which caused about thirty German casualties besides destroying the barricade and certain fortified buildings.

Another mine was sprung at Le Touquet during April, also with good results.

Work during this period was much as before, except that drainage difficulties lessened during the early spring.

PLOEGSTEERT—TRANSFER TO 48TH AND TO 50TH DIVISION (29TH APRIL TO 17TH JUNE, 1915).

On the 29th April the Company was transferred to the 48th (South Midland) Division, on the latter taking over a portion of the line held by the 4th Division. Work continued as before, two to three sections being employed on forward work by night. Six casualties were caused by shell fire in Ploegsteert village on the 9th May, otherwise the 7th Company casualties continued to be few.

Early in May a searchlight section (2 N.C.O.s, 10 sappers, 1 driver, with 6 oxy-acetylene searchlights on light wagons) was added to the Company. These lights did not prove to be of much practical value in trench warfare, both sides early discarding searchlights in favour of magnesium flares.

Transfer to the 50th (Northumbrian) Division.

On the 15th June the Company was ordered to join the 50th (Northumbrian) Division, V. Corps, near Vlamertinghe, and was inspected on the 16th by Brig.-General J. E. Capper, C.B., Chief Engineer, III. Corps. The Company marched early on the 17th June to billets at a farm 1 m. south-west of Vlamertinghe (17 m.), being inspected on the Grande Place at Bailleul by Lieut.-General Sir W. Pulteney, G.O.C. III. Corps, who complimented the Company on its work whilst under his command.

CHAPTER IV.

WITH THE 50TH DIVISION—ARMENTIÈRES AND THE YPRES SALIENT (JUNE, 1915, TO AUGUST, 1916).

Maps II and IV.

NEAR KEMMEL (20TH JUNE TO 14TH JULY, 1915).

ON the 20th June the Company marched with 151st Infantry Brigade to Dranoutre (8 m.), reconnaissances being made of the trenches opposite Wyschaete. On the 26th the Company moved into scattered billets in and about Kemmel village.

Work in this sector included rewiring with knife-rests the whole front of the 151st Brigade; strengthening the defences of Kemmel village and outlying farms by constructing machine-gun emplacements in cellars with concrete and other protection; supervising

infantry working parties on support trenches; making portable timber and wire frames for dugouts, etc. The weather was fine and there were no casualties.

POPERINGHE (19TH JULY TO 27TH SEPTEMBER, 1915).

On the 15th July the Division moved to Armentières, and the Company was billeted in the Asylum. Work was reconnoitred and arranged, but on the 19th the Company was moved at short notice to Poperinghe (14 m.) for special duty under the C.E. II. Army. Work was commenced on the 21st on a line of defended localities, woods, farms, etc., for which purpose two "entrenching battalions" were affiliated. The work continued till the 27th September and included the construction of numerous concrete machine-gun emplacements and many wells.

This peaceful interlude of two months was refreshing to officers and men after a year of continuous service in "the line."

During this time Capt. V. P. Smith left the Company to take over temporary command of the 56th Company R.E. 2nd-Lieut. L. J. Tessier joined and took over No. 3 Section on September 10th.

ARMENTIÈRES (28TH SEPTEMBER TO 6TH DECEMBER, 1915).

On the 28th September, the Company returned to Armentières and was billeted in the École Professionale; on the following day work on the trench system immediately south of the Lys was taken over. Two pontoon bridges were dismantled and rebuilt between Houplines and Armentières.

Owing to the now settled nature of trench warfare, the distribution and work of the Engineer companies had become very generally systematized; the companies were normally allotted to sectors corresponding generally to the number of brigades in the line, with sections working also on rear works, which helped to secure continuity during the successive brigade reliefs. Work in the back areas, under direct divisional control (hutting, stabling, etc.), assumed increased importance with the approach of winter.

During this period the line was comparatively quiet, though from time to time Armentières itself was severely shelled.

On the night of the 12th/13th November the Company met with a severe blow, a salvo of large shells bursting inside the École Professionale, where all the dismounted sections were billeted. The casualties amounted to 11 killed and 34 wounded. The funeral on the 14th was attended by the G.O.C. 50th Division (Major-General S. P. Wilkinson, C.B.), the C.R.E., Headquarters R.E., and detachments from the 1st and 2nd Northumbrian Field Companies. A redistribution of personnel throughout the sections became necessary, most of the casualties having occurred in two sections.

Lieut. E. Ashcroft, 2nd-Lieutenants T. A. Ross, H. A. Baker, and J. B. Glubb joined the Company during this month.

The work from September to December was of a varied nature, and included :—

Front System: concrete machine-gun emplacements, protected shelters for brigade and battalion headquarters, supervision of mining operations (handed over on the 9th November to the 64th Brigade Mining Section and later to the 172nd Tunnelling Company R.E.), revetments and drainage.

Back Area: hutting (101 huts were completed and 75 new huts erected during October), 3 bathing establishments each consisting of 5 large huts, divisional headquarters.

Miscellaneous: saw yard (production of trench boards, etc.), completion of two long main land drains (" Suez " and " Panama "), entailing excavation in places to a depth of 15 feet (these had been started in June by the 70th Company R.E. with Belgian civilian labour, amongst whom casualties from shell fire occurred from time to time), long lengths of canvas and other screening of roads and approaches east of Armentières, two bridges (each of two spans) near Le Bizet to carry 5-in. howitzers, trench tramways (both wood and iron rails being used) running along the roads leading from Houplines to the front system, and precautionary measures for the demolition of 12 bridges about Houplines.

THE YPRES SALIENT—SANCTUARY WOOD (6TH DECEMBER, 1915, TO 7TH MARCH, 1916).

Map IV.

The Division moved from Armentières on the 6th December to a sector east of Ypres (Sanctuary Wood to Armagh Wood).

After five days constructing bath huts near Bailleul the Company moved on the 13th to a farm 1 mile south-east of Vlamertingue, where headquarters and 2 sections remained throughout the winter with 2 sections in Zillebeke, an unhealthy spot and under view from the German trenches about Verbranden Molen.

The Germans would even shell one man exposing himself by daylight but, by careful arrangements to avoid his regular period of strafe, casualties to the R.E. personnel in the village were avoided. There were, however, many other casualties in the village and it was a trying time for the sections living there.

The front line varied in distance from the German trenches from bombing range on the left to some 300 yards on the right.

The work consisted mainly in improvements to trenches, revetting, making traverses which were few and far between, communication trenches and the ever-present problem of trench drainage. The water in the trenches on the right sector was, at times, over the top of " gum boots thigh." The problem was finally solved by letting

the water out through the parapet into No Man's Land and possibly into the German trenches.

The weakness of our artillery and the strength of the German artillery, particularly in 5·9-in. howitzers, was the cause of many casualties amongst the garrison and made working conditions arduous. The Germans were able to concentrate several batteries round the salient and used to perform on Monday afternoons on the right sector with an intense bombardment from at least three six-gun batteries. This generally had the effect of destroying the week's work and entailed starting all over again. Thanks to the regularity of this particular strafe the R.E. escaped excessive casualties, but the infantry garrison were not so fortunate and suffered severely.

A tramway was maintained from Zillebeke to the edge of Sanctuary Wood. This was partly 9-lb. rail and partly wooden rail with metal strip runners, a horrible affair which severely taxed the strength and temper of the pushing parties.

Nothing less than 16-lb. rail with stout sleepers was of any use in Flanders, especially as a tramway in those days was used by all and sundry as a road. Even batteries of guns have been known to drive up a tramway to the detriment of both.

The left sector, known as "The Birdcage," was very exposed to snipers and an unpleasant spot. It was possible, however, to get a very good view of the enemy through a telescope let into the parapet —about the only time the enemy were seen at this period.

The back sections were employed in reclaiming and revetting large supporting points north of Dickebushe (G.H.Q. line), constructing an advanced divisional H.Q. in Ypres ramparts, maintaining bridges over the Ypres–Comines canal and innumerable other back area jobs.

The mounted section earned the everlasting gratitude of the forward sections by its splendid devotion to duty in getting supplies and stores forward. It had the unpleasant nightly task of coming up *via* Lille gate–Shrapnel corner and back by Hell-fire corner–Menin gate. The names are sufficient to indicate the unpleasantness of this task, which was aggravated by continual "overs" from all directions.

On the 19th December the enemy made a gas attack on the neighbouring division, Zillebeke being heavily shelled to the detriment of the somewhat fragile "billets." Considerable damage was done to the trenches, entailing reconstruction work.

Major C. B. O. Symons, D.S.O., was severely wounded by shrapnel in the thigh on the 20th December. The command devolved on Lieut. O. D. Atkinson until the arrival of Capt. J. A. McQueen, M.C., on the 18th January.

2nd-Lieut. J. B. Glubb also was slightly wounded on the 20th, but remained at duty till the 1st January, when he had to be evacuated.

2nd-Lieut. W. F. Baldwin, D.C.M., joined on the 11th January. This officer had been awarded the D.C.M. and later the French Croix de Guerre for conduct at and subsequent to the battle of Loos, when a section serjeant in a field company.

With 1916 opened the second year of trench warfare. The works on both sides were becoming yet more extensive and thoroughly organized. The struggle became more and more one of attrition, both sides endeavouring by constant harassing fire, bombardments of localities, etc., to wear down their opponents until such time as mobile warfare should ensue. The introduction of heavy and light trench-mortars, increasingly accurate and concentrated artillery fire, controlled machine-gun fire, etc., rendered it possible for effective minor operations to be planned by either side and these gave rise to constant retaliation in kind. Such operations led to much destruction of trench works and of communications, and to active endeavour to interfere with working parties. Under these circumstances the casualties amongst the Engineers and working parties steadily increased, the work at times imposing a heavy strain on the sapper sections.

Conditions in the southern portions of the Ypres salient were particularly lively from January to July, 1916, during which time the Division occupied successively the following sectors: Sanctuary Wood–Armagh Wood (6th December to 7th March), Hill 60–the Bluff (9th March to 1st April), point 1 m. south of St. Eloi–Vierstraat–Wytschaete Road (4th April to end of July). During these seven months the Engineer companies obtained four weeks' rest in the neighbourhood of the Mont des Cats, which was, however, interrupted by their recall to the line from the 11th to 21st May owing to pressure of work there.

Throughout these months work continued to be organized on the basis of two sections in forward billets working with a brigade—the 151st (Durham Light Infantry) Brigade, under Brig.-General J. S. M. Shea, C.B., D.S.O. (afterwards G.O.C. 60th Division in Palestine), in the case of the 7th Company—and two sections in rear billets on purely divisional work.

Defences of "Mount Sorrel."

Early in December it was decided to strengthen the defences on the high ground immediately south of Sanctuary Wood (Hill 62—commonly called "Canny Hill" or "Mount Sorrel") with a view to its defence independent, if necessary, of the neighbouring low-lying trench systems. This entailed the construction and wiring of about 500 yards' frontage of support and reserve line, the provision of cut-and-cover dugouts for machine-gun detachments, headquarters, etc., and the widening, deepening and revetment of communication trenches. No. 2 Section (2nd-Lieut. Baker) carried out

this work. Good progress was made despite the work (which was in view and enfiladed from Hill 60) being severely shelled from time to time, and despite its occupation by troops before completion.

Lieut. O. D. Atkinson, M.C., was severely wounded on the 8th March after fourteen months' service with the Company. On the 15th February, 2nd-Lieut. J. B. Glubb was again wounded and 2nd-Lieut. R. E. Chaplin was posted to the Company (No. 1 Section).

"HILL 60" AND "THE BLUFF" (9TH MARCH TO 1ST APRIL, 1916).

Map V.

Early in March heavy fighting took place round "the Bluff," on the sector immediately south of that held by the 50th Division, where the Germans sprang a large mine and temporarily gained the Bluff and a considerable length of front line trenches. The Bluff, the mine crater and most of the captured trenches were retaken the following day by the 7th Division and remained in its hands.

The 50th Division side-stepped into this sector on the 7th March. The two forward sections of the 7th Company (remaining at Zillebeke) worked from the 8th to 21st on the construction of communication trenches and of a large barricade across the railway cutting immediately opposite Hill 60. Working parties were furnished from the 149th (Northumbrian Fusilier) Brigade, with one company of the 7th D.L.I. Pioneer Battalion co-operating. All the C.T.s were revetted with large wooden U frames and good progress was made despite the enemy's nightly harassing fire. Their whizz-bang shooting was remarkably accurate, but casualties were few. The chief enemy was the mud, which was of a particularly sticky nature.

On the 22nd March Nos. 1 and 2 Sections moved from Zillebeke into dugouts at the north end of the Bluff itself and No. 3 Section was sent up to join them. Work mainly consisted of clearing and reconstructing the forward C.T.s destroyed in the recent heavy fighting. These trenches were partly flooded and, owing to the numbers of enemy dead, of which the parapets appeared to be chiefly composed and to the torn nature of the ground, the work was difficult and trying. Good all-round progress was made in this work and also in constructing "the Loop" trench to restore lateral communication in the front line, and in fortifying the far lip of the big crater at the foot of the Bluff.

On the night of the 30th the large British mine, opposite St. Eloi and one mile east of the Bluff, was sprung. Confused fighting for possession of the crater followed. The next night the sector held by the 151st Brigade was severely shelled. As reliefs were then in progress casualties were heavy. The three 7th Company sections were, however, withdrawn with no greater loss than the destruction by shells of the dixies and other gear of two sections.

OPPOSITE THE WYTSCHAETE RIDGE (4TH APRIL TO 21ST JULY, 1916).

Map V.

On the 4th April the Company marched to hutments at La Clytte and commenced work with the 151st Brigade in the sector immediately opposite the Grande Bois (Wytschaete Ridge). Two, and later three sections were moved up into shelters in Ridgewood (1 m. north of Vierstraat).

The Company was destined to work on this sector from now until the end of July, with the exception of two welcome periods of rest (23rd April to 11th May and 21st to 27th May). This proved to be one of the most testing times experienced by the Company and contains features of marked interest. Description of the task and its performance is, therefore, given in some detail.

The "front line" held by the 151st Brigade consisted of a continuous sandbag breastwork and parados (1,600 yards in length), with shelters built into its reverse side. A small stream—the Haringhebeek—ran through low-lying marshy land 200 yards in rear of and parallel to the breastwork. Trench communication had as yet only been established with the extreme northern flank of it by means of a single C.T. running from the Brasserie on the Vierstraat Ridge through the Bois Carré. The whole length of the front line breastwork and the entire ground between it and the Vierstraat Ridge in rear was overlooked from the enemy's positions on the forward slopes of the opposing Wytschaete Ridge.

In the breastwork was a deep mine, one of a series of six constructed along the front of the Messines Ridge—a position much coveted by the II. Army and eventually taken by it in June, 1917. Hitherto the enemy, who was working hard on his own defences and wanted to be left in peace, had treated the long exposed breastwork kindly. But the springing of the huge mine at St. Eloi—whose existence he had not apparently suspected—put a very different aspect on things and henceforward the enemy did his best to hinder in every way the work of deep mining in this sector and all other works threatening his occupation of the ridge. Shortly before the 50th Division relieved the Canadian Division on this front, the breastwork had been heavily shelled and flattened out in several places. Altogether the picture on this sector was not an attractive one. The Canadian Division had put in hand a C.T. running from the neighbourhood of Vierstraat (1,700 yards in rear) called "Poppy Lane," in order to effect communication with the southern flank of the breastwork, but shelling had caused falls and consequent flooding and the C.T. had yet to reach and cross the difficult and marshy ground near the Haringhebeek. Its continuous revetment throughout was entailed.

The capture of the Messines Ridge in the summer of 1916 was

contemplated and the rapid development of good communications, of works giving cover to assaulting troops, supports and reserves, and of works protecting the deep mines, was considered urgent.

After thorough reconnaissance by the divisional staff, C.R.E. and brigade staff it was decided that the existing breastwork was to be re-made and strongly wired, that a support line was to be constructed parallel to it about 150 yards in rear, that the C.T. "Poppy Lane" was to be carried through and a fresh C.T. constructed from Bois Carré to the front line (this C.T. was later named "Stuart C.T." after Lieut.-Colonel J. Stuart, G.S.O.I., 50th Division, who was killed on the night of the 4th June when reconnoitring in its neighbourhood). Numerous dugouts, shelters and shell slits were to be added to the defences in Bois Carré for the accommodation of supports, assaulting troops, etc.

The organizing and carrying out of these works (other than work in the front line breastwork itself) fell to the 7th Company, large working parties—up to 600 a night—being allotted, together with a composite "permanent working party" of 100 and the assistance of a company of the 7th D.L.I. Pioneers.

As had been anticipated, the construction of some 1,200 yards of exposed support line (half-breastwork on account of water lying at 2 ft. 6 in. below ground level) proved difficult, as the whole was clearly visible to and enfiladed by the enemy. His six machine-guns in the Grande Bois and Hollandscheschur, assisted by heavy trench-mortars and well-placed rifle batteries, were scientifically used to frustrate the scheme. In addition, every bullet aimed at the front line and going over the breastwork went over the working party at a dangerous level. This entailed work being carried out simultaneously at many places and the support line soon had the appearance of a long row of lengthening grouse butts. These were at once—most appropriately—termed "The Butts" and soon acquired an evil reputation. The working parties, mainly furnished by the reserve or "resting" brigade at La Clytte, soon looked forward to a return to the comparative comforts of their unhealthy "front line."

Revetment with U frames, darkened with creosote, was adopted. Carriage was mainly overland and tracks soon became visible to the enemy, whose machine-guns and rifle batteries made the operation hazardous. Altogether the casualties amongst the sappers and the working parties averaged double figures nightly for some weeks, a fact which caused both Division and Corps headquarters to consider matters carefully from time to time. The importance, however, of the ultimate objective—the capture of the Messines Ridge—was the overruling factor and the work was carried on despite difficulties. By July, when the Division was again relieved by the 4th Canadian Division, the work was within sight of completion.

Relations with the infantry working parties were excellent throughout, the latter realizing the difficult task the small engineer sections were performing as a nightly duty for many weeks without relief. The appreciation of their work expressed from time to time by brigade and other commanders greatly encouraged all ranks of the Company, many of whom were feeling the continual strain of night work under these conditions.

By the middle of June the enemy's machine-guns in Bois Quarante and Hollandscheschur Farm, which enfiladed the support line work from both flanks, became so effective as to make work almost impracticable. To meet these, two sections of field guns stood by throughout the night and, by means of a system of lamp signalling from the front breastwork, were able to send a salvo at once in the neighbourhood of any machine-gun opening fire, and repeating salvoes as long as necessary. This prompt form of retaliation proved very effective, probably owing to the annoyance thus caused to the German working parties in the particular neighbourhood. After receiving a few such salvoes an offending machine-gun would generally keep quiet for twenty minutes or more. This arrangement was kept going for some weeks, encouraging the working parties and greatly improving matters except on misty nights when lamp signalling failed.

An unusual incident occurred one night. A certain N.C.O. received a bullet through his cap and it actually made a parting through his hair without more than scorching the skin. The N.C.O. was quite unconcerned and carried on as if nothing had happened.

During this period the Company lost one officer (2nd-Lieut. H. Russell, D.C.M.) and six other ranks killed, one officer (Lieut. F. W. Baldwin, D.C.M.) and nine other ranks wounded, losses which, though heavy in fact, appeared numerically to be extremely light under the circumstances.

2nd-Lieut. H. Russell, D.C.M., Russian Order of St. George, was killed by machine-gun fire on the night of the 12th July near Stuart C.T., a particularly difficult bit of work he had just completed. His loss was deeply regretted by all. He came out with the Company with the rank of serjeant in 1914, became C.S.M. in December, 1914, and R.S.M. 50th Division R.E. in July, 1915. On being commissioned in May, 1916, he was again, by request, posted to the 7th Company. He did excellent work throughout. His gallant conduct and cheery disposition coupled with strong personality and all-round efficiency endeared him to all. Engaged on difficult work he inspired the working parties with confidence. Although he only worked with the 151st Brigade for a short time, all battalion commanders of that Brigade took occasion to express their sense of the loss incurred.

Another markedly severe loss to the Company was that of Cpl.

W. Bromley of No. 3 Section, who was killed on the 19th July. This N.C.O. had also served with the Company in the field since August, 1914, and was conspicuous for marked ability, coolness and devotion to duty.

MONT DES CATS (23RD APRIL TO 11TH MAY, 21ST TO 27TH MAY, 1916).

Two "breathers" experienced at Mont des Cats (23rd April to 11th May and 21st to 27th May) were spent in an excellent farm billet just north of the Monastery, and were devoted to close-order drills, general overhaul, route marching and football. An excellent afternoon's mounted sports was carried out—somewhat to the detriment of the farmer's best pasturage but, as the attendance of himself and neighbours had been invited and all evidently enjoyed the show, no question of "dégâts" arose! The Divisional R.E. (with three players from the 7th Company) won the 50th Division football league.

During this time also, Brig.-General J. Shea, C.B., D.S.O., commanding 151st Infantry Brigade, came, at his request, to see the Company and expressed his appreciation of the work done by it whilst working in affiliation with his brigade from June, 1915 to May, 1916. General Shea spoke in warm terms and the Company was much gratified by his action.

The C.R.E. (Lieut.-Colonel C. W. Singer, D.S.O.) also formally inspected the Company on the 29th April.

On the 23rd May the Division was inspected at Flêtre by the G.O.C. II. Army (General Sir Herbert Plumer) when 2nd-Lieutenants Baldwin and Russell were presented with the D.C.M.

Serjt. F. Armstrong, Section Serjeant Mounted Section, became C.Q.M.S. on the 30th May, Cpl. T. Church becoming Mounted Section Serjeant. Both these N.C.O.s were later awarded the Meritorious Service Medal.

SOUTH OF KEMMEL (22ND JULY TO 4TH AUGUST, 1916).

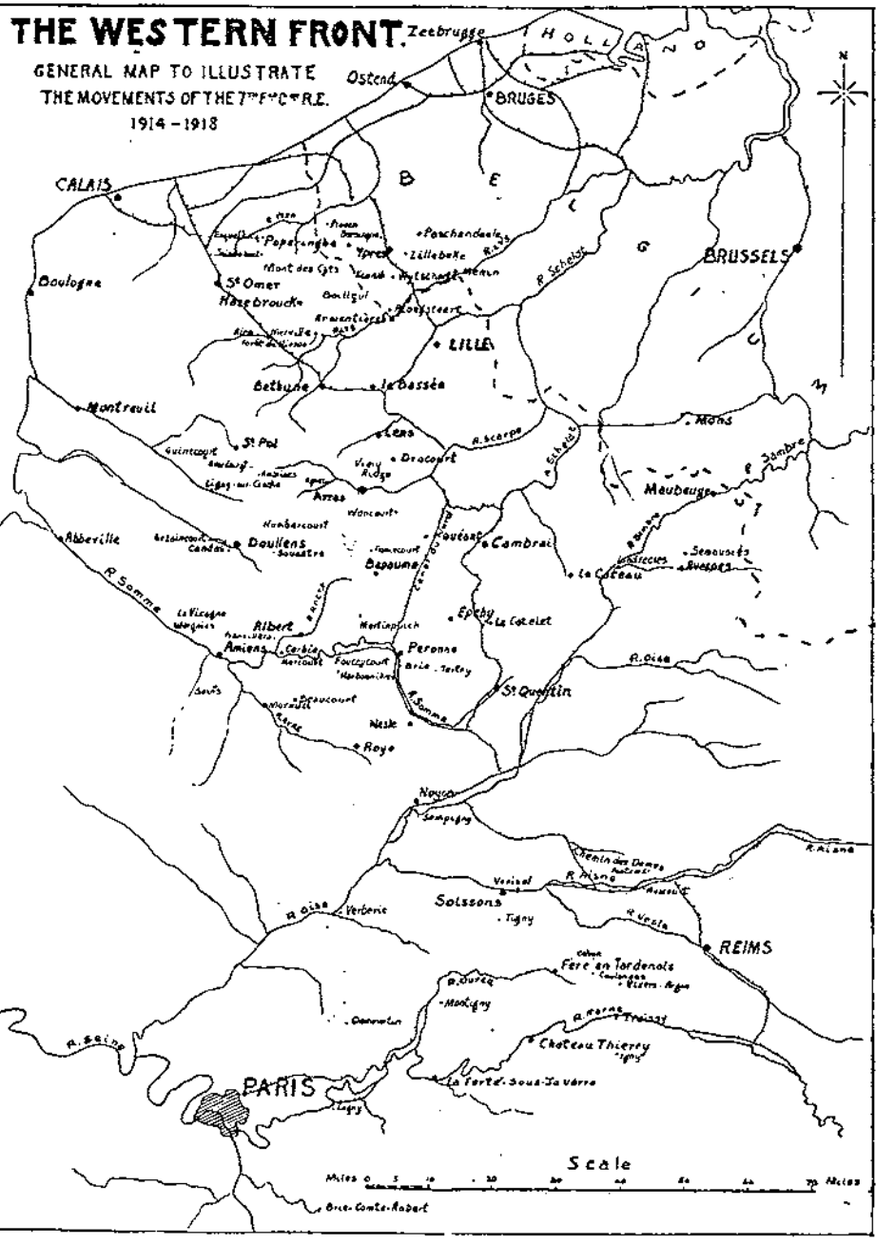
On the 22nd July the Division side-stepped to the sector Spanbrokmolen-Wulverghem.

This was the sector in which the Company had been in June, 1915, but now had the reputation of being a quiet spot and a "fattening" area for divisions destined for more arduous work.

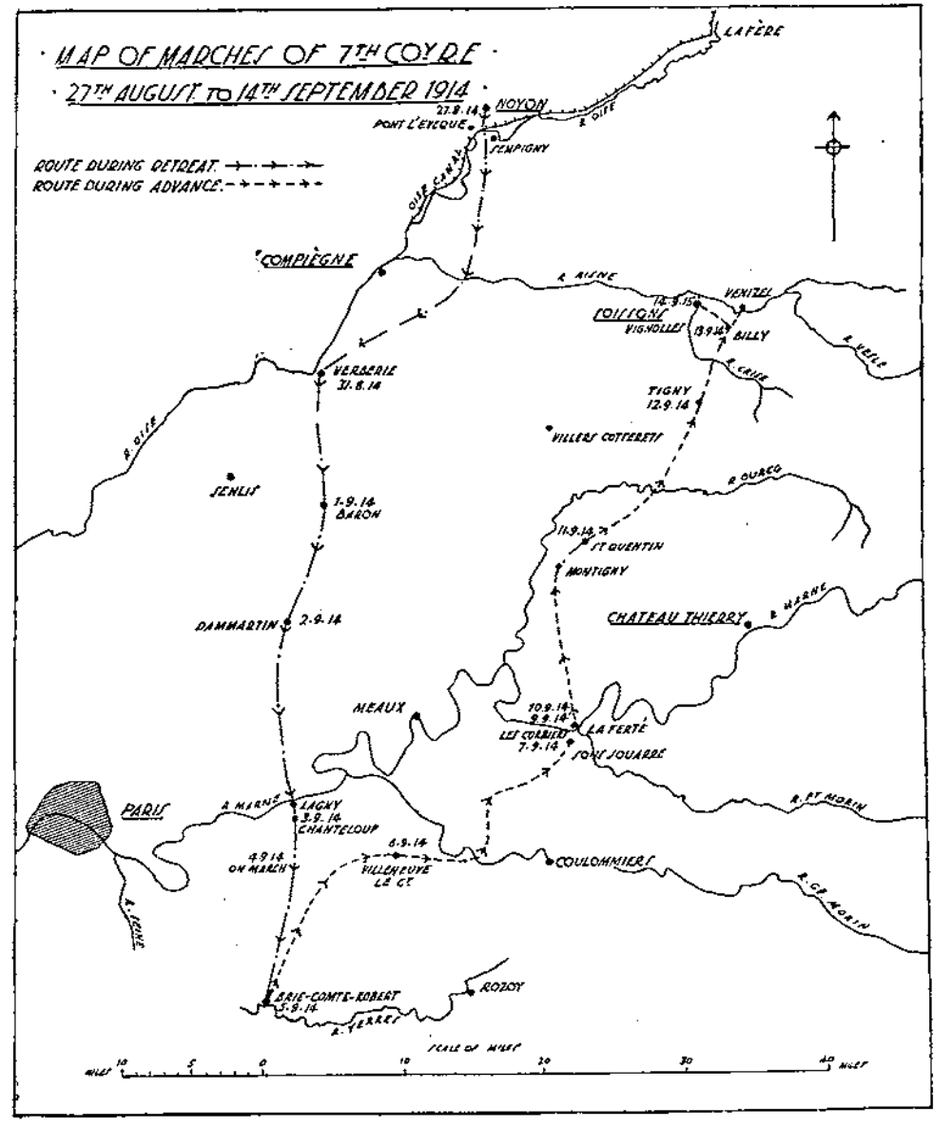
Owing to the ground falling away from the front line to a distance of 1,500 yards, conditions were very different from what they had been at Wytschaete. It was possible to work all day and actually to bicycle or ride up to the support line in daylight.

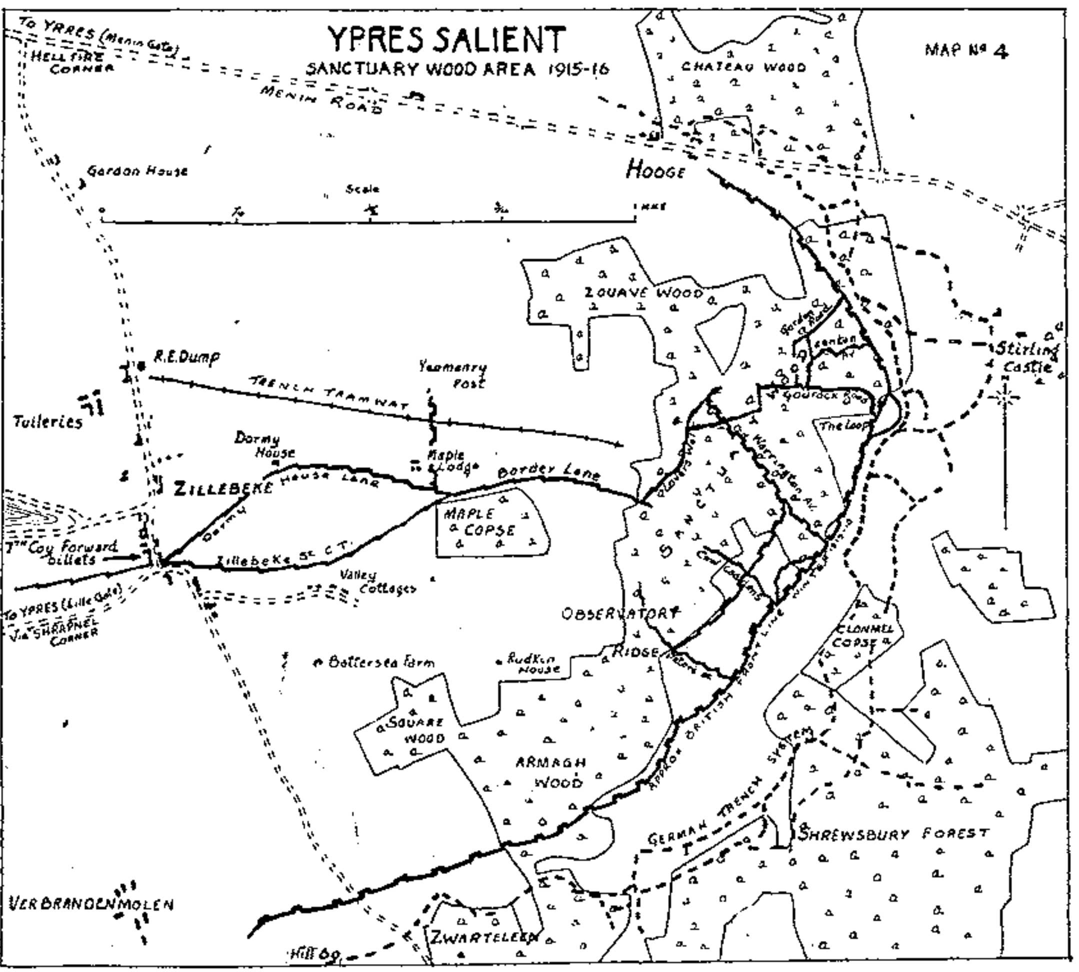
The line was again mainly breastwork and the work consisted in strengthening and improving works. Trench-mortar activity was very marked on both sides and the work was repeatedly destroyed

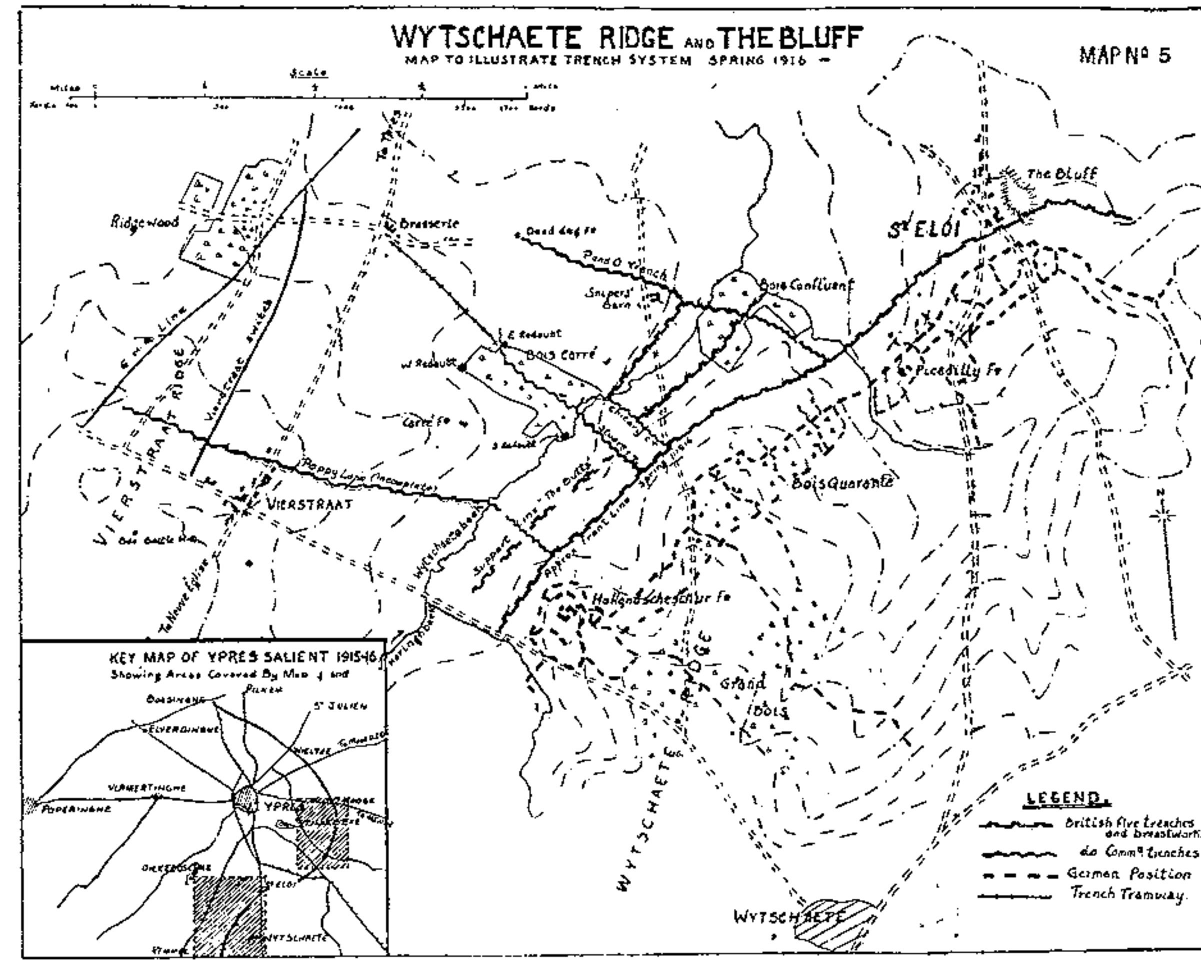
MAP No. 2.



MAP No. 3.




YPRES SALIENT
SANCTUARY WOOD AREA 1915-16
MAP No 4
To YPRES (Menin Gate)
HELL FIRE CORNER
MENIN ROAD
CHATEAU WOOD
HOOGE
Gordon House
ZOUAVE WOOD
R.E.Dump
Yeomanry Post
TRENCH TRAMWAY
Stirling Castle
Tuileries
Dormy House
Maple Lodge
Border Lane
ZILLEBEKE
MAPLE COPSE
The Loop
7th Coy Forward billets
Zillebeke St C.T.
Valley Cottages
To YPRES (Lille Gate) via SHRAPNEL CORNER
OBSERVATORY RIDGE
CLONMEL COPSE
Battersea Farm
Rudkin House
SQUARE WOOD
ARMAGH WOOD
GERMAN TRENCH SYSTEM
SHREWSBURY FOREST
VERBRANDENMOLEN
ZWARTELEEN
Hill 60


WYTSCHAETE RIDGE AND THE BLUFF
MAP TO ILLUSTRATE TRENCH SYSTEM SPRING 1916
MAP No 5
Ridgewood
Brasserie
Dead dog Fe
The Bluff
St ELOI
Bois Confluent
Bois Carré
Piccadilly Fe
VIERSTRAAT RIDGE
Poppy Lane
VIERSTRAAT
Bois Quarante
Hollandscheschuur Fe
Grand BOIS
WYTSCHAETE RIDGE
WYTSCHAETE
KEY MAP OF YPRES SALIENT 1915-16
YPRES
POPERINGHE
ST JULIEN
LEGEND.
British fire trenches and breastworks.
do Comm. trenches.
German Position
Trench Tramway.

by enormous German *minnenwerfer*. These made craters nearly twenty feet across and the whole support line area was indented with them. Fortunately no casualties were incurred from this cause as the *minnenwerfer* were usually sent over at night.

A strenuous effort was made by the infantry battalions to develop an organization for works and an innovation was made by attaching a sapper officer to act as liaison officer with the Brigade. This officer gave technical advice and assistance from a small R.E. party of eight sappers detailed for the purpose and the arrangement was particularly valuable in ensuring continuity of work and effort by the front line battalions.

EN ROUTE TO THE SOMME (AUGUST, 1916).

Map II.

The Company handed over on the 6th August and marched at dawn on the 8th to its previous billet on Mont des Cats, and spent two days in training.

2nd-Lieut. Glubb rejoined on 9th August and took over the duties of A./Captain.

Entraining at Godvaersvelde on the 11th August, the Company detrained the following morning at Candas, 5 m. south-west of Doullens, and marched to Boisbergues (6 m.), where three wet days were spent in bivouac. The Company always carried one three-foot stick per man, with a nail in one end and a length of spunyarn attached. Four of these and four ground sheets made an excellent bivouac for four men.

On the 15th the march was continued to Wargnies (13 m.), on 16th to Mirvaux (9 m.), on 17th to Franvillers (12 m.), where 12 days were spent in training. Leaving Franvillers on the 30th the Company marched to bivouac near Bécourt (10 m.), 3 miles east of Albert.

(To be continued.)

CORRECTIONS.

In "The History of the 7th Field Company, R.E.," published in the March, 1932, *R.E. Journal*, the following misprints occur:—Page 55, line 16, for "Lieut. C. S. Wilson" read "Lieut. E. E. B. Wilson"; line 45, for "nine yards" read "ninety yards"; page 56, line 44, for "Lord Robeats" read "Lord Roberts."

THE FASTNET RACE, 1931.

By CAPTAIN R. H. B. LONGLAND, R.E.

THE three ordnance guns on our burgee are worth their weight in their own heraldic gold. When other yachts were prowling round for anchorages and landing steps, striking harsh bargains with waterside boatmen and, strange to relate among yachtsmen, looking for water-taps, *Ilex*, on the morning of August 9th, was comfortably made fast to the Gun Wharf grid at Portsmouth. The R.E.Y.C. owes a great deal to the kindness of the R.A.O.C. and R.A.S.C. officers who allowed us to berth there and the convenience of having fresh water alongside was only one among many comforts.

Sunday was a day of work and household shopping. As the tide went out we got round the ship with brooms and scrubbed off any mud or weeds, but found very little. One of the less disreputable members of the crew was then sent ashore for meat and fresh vegetables, and Monday saw the arrival of queues of grocers' boys, followed triumphantly by the cooked-meat bearers with what proved to be a most useful item in the messing.

Gibson, who had sailed with us from Weymouth, left the ship on Sunday and Sheppard arrived on Monday, so except for Langrishe we were complete. The unerring eye of the skipper spotted that the main brace looked very shaky, so with the willing assistance of the rightful owners of the Gun Wharf we spliced it in the saloon before sailing for Cowes. Feeling ready for anything, we got under way at 11.00 hours, with a fair breeze blowing and enough lop to make the first meal below slightly hurried; the roller-reefing gear was put into action several times on the way, until the crew became more or less familiar with it, and at 15.00 hours we dropped anchor off Cowes, where Giles, full of enthusiasm for various gadgets of his own suggesting, boarded us from an expensive-looking motor-boat.

Mustering two yachting caps, a beret, and several unclassified hats, we went ashore, to find Cowes full of the ocean-racing fraternity. Langrishe joined us in the evening, so the crew was complete, and we went on board at 23.00 hours laden with all the last-minute purchases, having successfully resisted the temptation to buy any yacht club burgees in platinum and diamonds, which seem to be the main export of Cowes.

The 11th dawned fine and warm. What little breeze there was died away before starting time, and all the eighteen yachts drifted

westwards with the tide, dropping their kedges behind the starting line. The crew now consisted of nine: Watkinson, the skipper; Sheppard, first mate; Parker, second mate; Barker, Longland, Langrishe and Price, in two watches; Biddle, the wireless operator, chronometer man and spare hand, and the invaluable Carter.

When the starting gun went, all *Dorade's* winches rattled in unison, but nothing else happened; for half an hour not a yacht moved. Then at 10.30 hours (sun time) a slight breeze sprang up and with all sail set we crept along Spithead, presenting the amazing spectacle of eighteen yachts of almost every design abreast, with hardly room for a dinghy between some of them. *Shamrock* and some of the big class coming towards us took one look at the imposing sight and promptly went about.

The sun grew hotter and Lido kit began to appear. Garments were flung off in all directions. Sheppard put on a turban, and a Mexican straw sombrero was distinctly visible on *Jolie Brise;* we had none of these in *Ilex*, but Parker's pyjamas at a short distance looked very like R.E. full dress, so sartorially we held our own.

All was calm and peaceful, while over the sacred waters of Cowes floated the lilt of an old-world ballad from *Water Gypsy* with the tinkling of Sam Wetherill's guitar. The official nature and wide circulation of *The R.E. Journal* prevent the inclusion of the words here, but they must have shaken Cowes to its foundations.

At No Man's Fort the line soon scattered as the wind began to freshen, and setting the medium jib topsail in place of the long hoist jib topsail, which was sagging, we made a long tack out to sea, overhauling two or three yachts on the way.

At dusk we were abreast of Ventnor, having gone inshore, and as the wind backed to N.W. by W., we set course W.S.W. past St. Catherine's Head. It was a very peaceful night and sailing was pleasant though very uneventful. We overhauled three yachts during the night, so our hopes began to rise, as we had been well in the lead during the day.

Dawn of the 12th broke to a light wind and a choppy sea, with nobody in sight. The morning watch had hardly settled down to their spell when a horrid cracking sound brought all hands on deck. The new hollow topmast had broken clean across the middle, bringing down the jackyarder in a tangle of halyards and stays.

What the cause was nobody could say, but from a subsequent examination of the broken parts, it looked as if the spar, which was very whippy, had failed as a strut when the jib topsail was sheeted home hard. Two hours were spent in clearing away the tangle, but in the freshening wind and sea no real work could be done aloft, so we went about on a northerly course into West Bay, sadly missing our topsail, as the wind was beginning to fall light again. The official log

reads, " Speed very slow, morale very low ebb." If, as seemed the case, we were going to have a light-wind Fastnet race, then something drastic would have to be done if we were to come home with any sort of honour. Splicing the spar was out of the question; after a conference we decided to rig the spinnaker boom as a topmast, while a jackyarder spar could take the place of the spinnaker boom, although very much shorter than the real boom. This was managed by setting the gooseneck in the shrouds to give the correct length to the boom, and as a matter of fact the spinnaker, when we eventually set it, drew as well as before, if not better.

All the gear was got ready on deck, after the new topmast had been drilled for the fid, and after one failure we got the whole lot up at 17.00 hours. *Skal* and *Amaryllis* passed us while we worked, the latter sending rapid signals by lamp in proper navy fashion, offering the loan of a spare topmast. By this time, however, the work was well on the way to completion, and, anyway, the acceptance of a spare topmast would have disqualified us, as by the rules of the race no gear is allowed to be taken on board between the start and the finish. By 19.00 hours all was complete, after some amazingly simian feats of balance by the skipper at the masthead, where he knotted, lashed, hammered and spliced, apparently hanging on by the tail of his beret, and back we went on our course again.

Biddle came off the worst out of all this, as a falling block scored a neat bull on his head, and he appeared shortly afterwards swathed in bandages. As Lady Macbeth so aptly remarked:

> " Who would have thought the old man to have had so much blood in him? "

The delay lost us the tide round the Start, and at dawn on the 13th we were still struggling to round the Point, with a light wind and a foul tide. At 11.00 hours a wind came up from the west, backing later to S.E., so we set the spinnaker in style, praying all the while that the new topmast would take the strain.

Everything in the garden was lovely; brilliant sunshine, no sea, and all sails drawing; but the calm weather was a trap for the unwary, for those with delicate interiors, which by this time should have been broken in to meals of cold mutton in a rocking cabin, were lulled into a false sense of security, recking little of the wrath to come. There were now no burgee halyards to the masthead, so a venerable red silk handkerchief, which had once belonged to somebody's grandfather, was hoisted at the ensign staff, and remained there to the Fastnet.

Thus with the red flag flying we passed the Lizard, where we had a frenzied search in the code-book to tell our troubles to the world. Except that " spanker " was the nearest approach we could find to

"spinnaker," we made our signal successfully and went our way at about eight knots. By this time the wind had freshened and we handed the long hoist jib topsail and the reaching staysail, the latter having been set when the spinnaker failed to draw. The wind was now S.E. and a following swell had come along, so with our course N.W. by half W. we were running dead before the wind. Grandfather's silk handkerchief here proved its value, as in the gathering darkness one could just tell from it if there were any danger of running by the lee. With the new topmast, which looked about as thick as a cigarette, a gybe would have been fatal.

As we approached the Runnelstone where, at 21.15 hours, the log was streamed, a cold light rain set in, and the weather which had been fairly good up to now showed signs of breaking. The glass began to fall, the swell became steeper, and altogether life for the watch on deck was a good deal less pleasant than before. This was the only day in the race when we got a sight at the sun with the sextant, and all the later reckonings were made from the log which, until it was mistaken for a pilchard by some optimistic dolphin or shark off the Cornish coast on the last day of the race, served us very well.

The wireless weather signals received were usually in reverse of the actual weather we were getting, so we rather lost confidence in them. Later on the aerial and leads got so soaked that all reception failed, and we were spared the comfort of being told in the middle of a howling gale that a deep depression had settled over Chatham, or that Bognor Regis was bathed in sunshine.

The wind on the 14th was a strong S.E. breeze, before which we ran at 7½ knots. Cooking had become almost impossible owing to the sea, and conditions below began to get a little unpleasant, as each succeeding watch came down and added more wet garments to the increasing pile in the cabin.

The glass continued to fall in the most depressing fashion, and the wind, veering to the south, strengthened considerably, so that those who had the day before rejoiced in the pleasant and gentlemanly pastime of ocean racing began to revise their opinions and wilted visibly when offered any other form of food than a dry biscuit. Hunger and cold made the spirit very willing, but the flesh was sadly weak when confronted with the atmosphere below.

At mid-day we were about half-way between the Lizard and the Fastnet, and it was then that we sighted *Dorade* homeward bound, evidently bent on repeating her Atlantic success. At about 16.00 hours *Noreen*, *Mistress*, *Water Gypsy*, *Highland Light*, and one other passed us on their way home, and later on at 20.00 hours *Jolie Brise*, *Neptune* and two others came in sight. This cheered us a little as they could only be about six hours ahead of us, so granted a fair

passage round the Fastnet we might still be somewhere in the race, in spite of our previous bad luck.

The 14th went out in an angry-looking yellow sunset, with the clouds promising more wind. As the dusk fell we picked up the Fastnet Light on our port bow and hauled our wind a point. *Amaryllis* was now with us and we went round the rock in her company. In the dark and with the increasing wind and sea it was a very difficult job, as the indraught of the tide made a number of short tacks necessary, and the watch on deck had a very anxious time. The ship was getting a pretty hard pounding, and sleep below was broken and uneasy, making it all the more tiring when the time arrived to go on deck.

At the Fastnet we attempted to make our number with a pocket torch, as the signalling lamp had failed, but it seemed doubtful if anything had got through. At last we got clear, and setting the course S.E. by E. we started close-hauled on the homeward trip. The glass was still falling, and the wind had freshened a good deal, so the jib header was handed during the night.

Saturday 15th brought us a strong wind and a big cross sea, which made it very tiring work at the helm and uncomfortable below. Cooking had definitely ceased and biscuits and chocolate had to satisfy most of the crew until we reached Plymouth, with the exception of two members who whiled away the time swilling beer and eating a peculiarly rich brand of cake, to the chagrin of those in the bunks. As the day went on the wind increased and the glass continued to fall; it was evident that we were in for a gale, and that the worst time was still to come. This was a trying day. Everybody was tired, wet and cold, and if it had not been for a kindly sun, which appeared at intervals to brighten up the grey stretch of sea, life would have been very depressing. The ship was making about 6½ knots, and holding a course of 5½ points off the wind, which was about a point more than her usual course, but with the heavy cross sea it was better to lose a point than to get uneasy sailing with a consequent loss of way.

The unfortunate Carter from this time became the ball in a species of below-deck tennis, being violently served from side to side of the fo'c'sle, and ending in a double fault and a heap of pots and pans on the floor where, wedging himself in between the lockers, he stayed till things were more peaceful. Carter is prepared to swear that about this time a cup thrown from its hook was caught by a hook in the row above!

The wind showed signs of heading us, and it was with some anxiety that we awaited a landfall, as the whole of the course from the Fastnet had been laid by dead reckoning, and with the weather getting steadily worse we did not want to spend much time working

1.—Soon after the start. *Maitenes*, *Water Gypsy*, *Mistress*.

2.—Drilling the spinnaker boom for the fid.

3.—Making for quieter water in West Bay. The broken topmast on deck.

4.—Wednesday afternoon.

The Fastnet Race 1931 1-4

5.—The spinnaker boom as topmast pulls its weight.

6.—Carter.

7.—With the red flag flying.

8.—Stowing sail.

The Fastnet Race 1931 5-8

our passage round the Cornish coast. By midnight however, we could just make out a light ahead which proved to be Pendeen and the general morale rose a little, but the worst time was still ahead of us. Fate had not been kind to *Ilex* this time. The loss of the topmast, in addition to the time taken to replace it, had lost us the tide round the Start, and now, at the worst patch of weather we had yet struck, we found a foul tide at the Longships. We saw the light long before dawn, but it was past nine o'clock before we were past, after making two long tacks out to sea.

The ship made a certain amount of water and when we tried to use the bilge pump in the engine-room we found it choked ; a hurried research into the bilge showed that the labels of the various meat tins had found their way into the pump inlet, and as it would have taken a long time to clear out the mess, a pump was rigged on deck and the ship pumped dry. Dry is hardly the right word to use at this stage, as everything below was unpleasantly damp and clammy.

By 11.30 hours we were off the Lizard, in a gale of wind and a heavy following breaking sea. The wind recorded at the Yacht Club in Plymouth about this time was from 40 to 45 m.p.h., and must have been a little more at the Lizard itself. A reef and a half had been down since 4.30 hours the previous morning and we were able to hold this canvas all the way home, while the famous topmast, looking about as thin as a cigarette, held in spite of all the strain put on it. Past the Lizard we had to pump again and found a good deal of water in the ship as the strain had been enormous ; in addition there had been a good many cold douches down the hatch at unexpected moments, usually when a watch was coming on deck. This, however, was not really surprising as the waves washed continually over the deck, and the lee rail was awash all the time. Steering was heavy work, and the helmsman had to be made fast to cleats in the deck, as several times an extra hard kick of the tiller had lifted him into the lee scuppers.

A gybe gave us a long reach as far as Fowey, where we gybed again and made Rame Head in one stretch. The sea was lessening appreciably, and as we neared Plymouth spirits rose at the thought of a hot meal and a dry bed, two things which had been in everybody's thoughts for many hours past.

Plymouth Sound looked very welcome. Our only regret was that there was too much wind to be able to set the spinnaker and come in under full canvas. We gybed in the Sound, and after a few heated arguments about the finishing line and a hurried study of a very damp and sodden copy of the sailing instructions we crossed at 19.20 hours. A launch belonging to the King's Harbour Master came out to meet us and guide us to an anchorage, but this was not so simple as it sounds, as the railway official in charge of Millbay Docks, soon

referred to (*sotto voce*) by the crew as "that —— porter," had his own ideas about where we should anchor, which he conveyed to us in a private signal code. Exactly how many times we dropped anchor, wiped our brows, cursed, put the winch handles on again, barked our knuckles on the deck, weighed anchor, and then went through the whole business again in a different place, nobody can quite remember, but at last it was done and we straightened our backs with thoughts too deep for words.

It was very pleasant to feel that all our troubles were over. It was still more pleasant to find three of the Marines alongside in a dinghy, with an invitation to use their mess as our home and to come ashore for meals, beds and baths as soon as we liked; a most delightful example of true hospitality which we accepted gratefully.

The next joy was the appearance of Carter's head in the hatchway and an announcement, "Supper's ready, gentlemen," and going below we found a vast array of eggs and sausages, which went a long way towards filling several very aching voids.

Amaryllis was already in, but we found we had beaten her on handicap, and as we got more news we didn't seem to have done so badly after all, as we were eighth out of eighteen. That unlucky topmast had cost us four places in the race at least, and perhaps more. One thing marred the finish, the tragedy of *Maitenes;* several of us had met Colonel Hudson at Cowes before the race and it was with a real regret that we learned the news of his death. This was an unforgettable Fastnet race. It had been a pretty hard time for all those in it, and *Ilex* stood up to her buffeting wonderfully. Some of the facts and figures may be of interest to those who have raced before.

Best day's run: 15th, 162 miles.
Best 24 hours' run: 18.00 hours 13th to 18.00 hours 14th, 177 miles. Average, 7·4 knots.
Best 6 hours' run: 14th, 12.00 hours to 18.00 hours, 49 miles. Average, 8·2 knots.

Not too bad in a gale!

THE CROSSING OF WATER OBSTACLES BY ARMOURED CARS.

By MAJOR B. C. DENING, M.C., R.E., *p.s.c.*

IT has been obvious for some years that the problem of maintaining the mobility of armoured forces may, in many countries, rest upon the means available for moving heavy vehicles over water obstacles. Particularly is this the situation in the case of armoured cars with their wide radius of action. It was therefore decided recently, by means of experiments carried out in Southern India by the 6th Armoured Car Company, in conjunction with the Q.V.O. Madras Sappers and Miners, to examine various methods of taking armoured cars over water obstacles.

It will rarely be the case that an armoured car unit, operating widely, will be given bridging material sufficient completely to *bridge* even a small gap, such as a canal or stream of even 50 feet width. Hitherto, the possibility of crossing water obstacles with such cars has mostly rested upon rafting. In the experiments referred to above it was decided to pursue three lines of investigation: *Rafting*, *Submersion*, and *Overhead Suspension*.

The experiments were carried out either in the Kabini River at Nanjangud, near Mysore, or in tributaries thereof.

RAFTING.

Rafting to date has been of two types. First, there has been the raft made of Service pontoons, easily capable of transporting armoured cars. Second, there have been smaller rafts improvised out of any buoyant materials available, *e.g.*, barrels, petrol tins, tarpaulins and straw, etc.

It was first decided to find out how to effect improvements, given suitable rafts. Next, on the assumption that lumbering Service pontoons will not normally follow armoured car units about, to see what the chances of improvisation really were.

Improvements in Methods of Rafting.

As regards improvements in methods of rafting, the experience of several seasons has been that, with Service equipment as it is at present, an undesirably long time is taken in moving an armoured car company over a river even of moderate width. Ramps are

usually necessary and a shore bay or wharf has to be made on each side. Against a current or high wind rowing is laborious and slow. If it is decided to use the current by a flying bridge, a cable must be moved across and fixed, a long operation with heavy steel wire rope. Ordinary rafting has been so slow that a unit of 16 to 20 cars might easily take 24 hours to cross a small river. Such delay might prove fatal in an operation and certainly would justify a detour by the unit of up to 200 miles on good roads.

The following methods of speeding-up rafting were found feasible. Where it is desirable to place a cable across a river, this can be greatly accelerated by mechanical haulage. A light rope was run through a block fixed on the far bank and a Thornycroft lorry was used on the near side to haul the steel cable over. From a normal 3 hours the time required was reduced to 1½ hours and could with practice be reduced still further.

As regards actual rafting, mechanical haulage is invaluable. The best method, it was found, was to attach a hauling cable to the raft fore and aft (see Sketch I).

One lorry only was necessary. The hauling cable to the far bank passed from the raft through a snatch block A back to the hauling lorry. The hauling lorry passed between pegs C and D to save unnecessary signalling. The time required for off-loading of the car at far side was ample for the hauling lorry to unhook from one cable, return to the beginning of its run, and hook on to the return cable which had been paying out in rear of the raft.

To eliminate any possibility of the raft drifting downstream, an upstream cable AB and a traveller can be used. With this method a certain element of seamanship is required to get the raft into the landing stages. (The lorry must haul direct on the raft. There is no control over the raft if the lorry hauls on the traveller.)

To make the ferry " foolproof," it was found that upstream and downstream warping lines (the correct distance apart) passing through blocks on the raft pontoons were quite satisfactory. The warping lines made the raft come in square, and measured breastlines to the shore practically eliminated " seamanship " in bringing the raft into the landing stage.

By this method, across the Kabini River, which here admittedly had very little current (2 m.p.h.) but was some 400 feet wide, cars were moved across in 10 minutes each, from the top of one bank to the other, whereas formerly 20 to 25 minutes were required. This operation was repeated successfully by night.

Improvisation of Rafting.

Investigations were made as to the chances of improvising rafts. The general conclusion was definitely negative. Improvised rafts are suitable only for the smaller weights and a field gun is probably

No. 1.—The site. Car being prepared for immersion. R.T.C. and S. & M. personnel.

No. 2.—Car being hauled into water.

No. 3.—Settling by the stern.

The crossing of water obstacles by armoured cars 1-3

No 4.—Half-way across. In 6 feet of water.

No. 5.—Coming out again.

The crossing of water obstacles by armoured cars 4-5

the heaviest weight that can be carried by this method. Barrels, serviceable and in sufficient numbers, are not available in rapidly-moving warfare, any more than rigid pontoons are. Even if sufficient of other improvised agents, *e.g.*, petrol and oil drums, stuffed tarpaulins, etc., were available, it was found impracticable to make rafts large enough to carry armoured cars. It is clear that for rafting armoured cars, great dependence must, in future, be placed upon the new folding boats under experiment at home, being carried with armoured car units. Given such, by the methods of acceleration referred to above, comparatively rapid rafting will be attainable. The shore bay may cause delay unless a ready-made type can also be carried with the rafts.

Submersion.

The success of travellers in Africa in crossing rivers in motor-cars by having them dragged through under water suggested the experiment of trying the same procedure with an armoured car. The general idea was to remove certain vulnerable parts from the car, drag it across under water, replace the parts and actually see how soon the car could be under way again. By this method, given the haulage arrangements, rafting materials could be dispensed with. The method was obviously very dependent upon the nature of the bottom, but in the absence of boulders and rocks appeared feasible, especially at places such as submerged fords, marked on a map.

A site was selected over a branch waterway of almost standing water, similar to a canal. Sketch II shows the arrangements, while the photographs show the experiment in operation.

In the absence of stout trees, anchorages A and B to take a strain of 5 tons each were prepared on each bank.

A 1″ steel wire rope was fixed fairly taut between each anchorage, to serve as a standing cable along which the car would be pulled.

A 4″ shackle and single block were fixed on to the 1″ cable as a runner.

The shackle was fixed to the front of the car to be pulled over, the connecting cable making an angle of about 20° with the 1″ steel wire rope.

A 3″ S.W.R. was attached to the shackle. The 3″ S.W.R. was passed round a snatch block made fast to the anchorage "A" on the far bank. The loose end of the 3″ S.W.R. was attached to the tail of the hauling car, on the near bank. When the hauling car moved forward, the other car was pulled straight into the river.

To avoid damage to local property, no provision could be made for the car to be pulled out on the far bank. This was the reason for the cable and snatch block attached to the rear of the immersed car. The latter had to be pulled out backwards at the point where it went in. This was actually a more severe test than a straight in

and out haul would have been, as the car had time to settle in the mud.

The following steps were taken with the car itself which was a Crossley :—

(i) All lamps, dynamo, starter motor, magneto, klaxon horn, accumulators, shocking-coils, switch-box complete, and carburettor and seal induction manifold with blind joints, etc., were removed.

(ii) The engine breather pipe, gear-box breather pipe, exhaust pipe, air intake on autovac, and engine oil-filler pipe were plugged.

(iii) Blind joints were fitted in the main and auxiliary petrol tank fillers.

(iv) The steering arm was locked to the front axle with a " U " bolt.

The above preparations were completed by the crew of the car (four men), plus a Royal Tank Corps fitter, in 35 minutes. The car was left immersed in 6 ft. of water for 1½ hours. The time taken by the crew and the fitter to reassemble and repack the car was 55 minutes.

It was found that :—

(i) Water had entered the crankcase *via* starting handle, valve chamber and tappets.

(ii) Water had entered two cylinders *via* valve chamber and valve guides, silencer and exhaust pipe.

(iii) Water had entered the differential casing *via* the universal ball joint.

The time taken by fitter and crew to remedy the above was 1½ hours.

(i) The water was drained off the crankcase *via* the two oil level cocks.

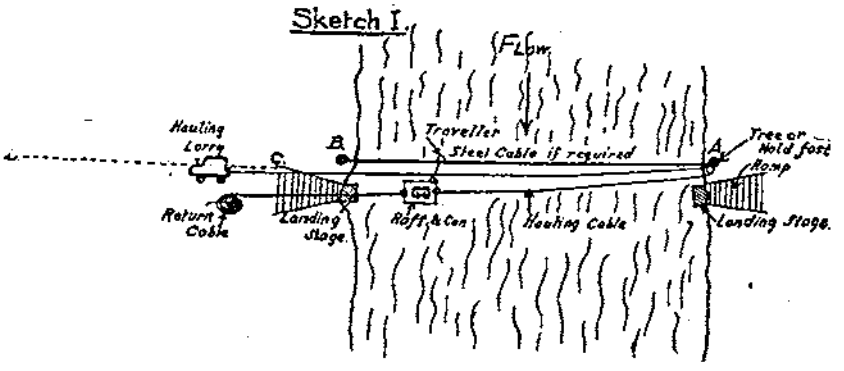
(ii) The engine was run on two cylinders, the water in the other two being blown out through the compression taps. After the two plugs of these cylinders had been dried and cleaned the engine ran on all four cylinders.

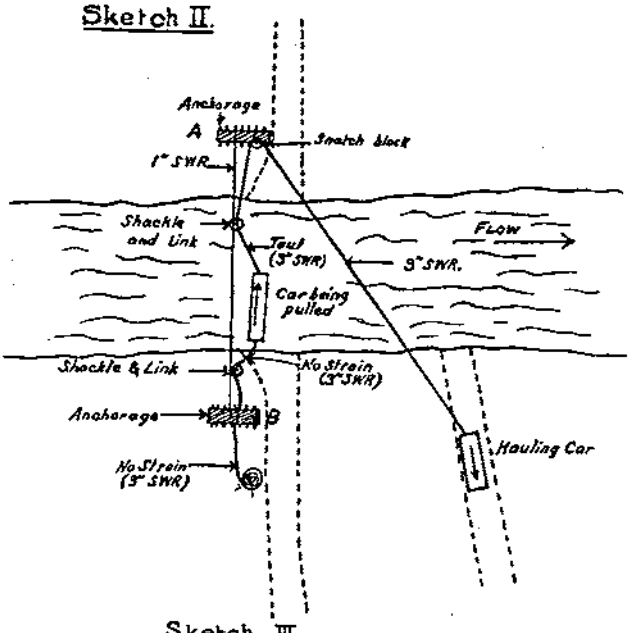
It was found necessary to drain off the differential casing and refill with fresh oil.*

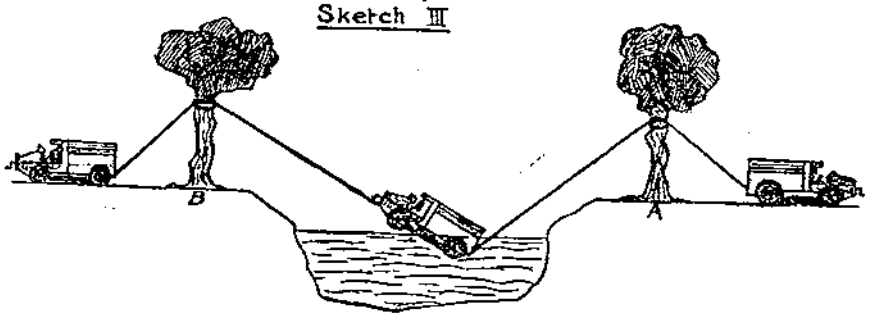
It was considered that if the car had only been under water for 10 minutes, *e.g.*, the time necessary to tow it across the river bed, these troubles would not have occurred and the car would have been fit to run in 1¼ hours.

Another large delay in carrying out this operation was due to the

* Subsequent overhaul in heavy repair workshop disclosed no ill effects on account of submersion.


Sketch I.
Flow
Hauling Lorry
B
Traveller
Steel Cable if required
A
Tree or Hold fast
Ramp
C
Return Cable
Landing Stage
Raft & Car
Hauling Cable
Landing Stage.


Sketch II.
Anchorage
A
Snatch block
1" SWR.
Shackle and Link
Taut (3" SWR)
3" SWR.
Flow
Car being pulled
Shackle & Link
No Strain (3" SWR)
Anchorage
B
No Strain (3" SWR)
Hauling Car


Sketch III
B

time taken making the anchorage. It appears that, once the engine is submerged, a few extra feet of depth will make little or no difference to the ease with which the car can be restarted, and that a deep ford with existing anchorages, *e.g.*, trees, is infinitely preferable to a shallower ford with none.

Much of the erection shown in Sketch II would not often be necessary (*e.g.*, the anchorage B and 1" S.W.R.). The conclusion arrived at was that, given a reasonable bottom and a stout tree or building on the far bank, thus avoiding the construction of anchorages, with practice a car could be towed across and restarted in two hours by this method.

OVERHEAD SUSPENSION.

A third method of transporting cars was examined, based upon civil practice in the handling of heavy timber over waterways. This method is based upon the principle of partly taking the weight of the suspended object by making the latter displace water.

Sketch III indicates the possibilities. The difficulty arises in finding adequate trees A and B at places where a car can run in and out of the river. This was experienced at Nanjangud and this experiment had, therefore, to be attempted elsewhere, using spars instead of trees and an A.T. cart in place of a car. It appeared that the principle is definitely applicable but that the difficulty of finding the suitable uprights A and B, even if derricks formed from Martel cubes were carried in the field and used, precludes the adoption of this method. It is also dependent upon water not penetrating the object carried to any extent.

This method might have application over deep frontier chasms, using holdfasts instead of uprights A and B.

CONCLUSIONS.

The final conclusions arrived at were that by training units in the use of mechanical haulage, steel wire ropes, etc., the mobility of armoured car units could be definitely increased and perhaps up to 12 hours gained at any one crossing. The need for the carriage of a readily transportable raft and shore bays or landing stages was manifest. Improvisation of rafts was proved out of the question. The method of hauling cars through water was shown to be feasible, particularly if cars were partially designed to that end.

Even if the amphibious characteristics of the latest tank should become applicable to all vehicles, unless such vehicles were supplied with tracks, it was seen that there would still be the need for haulage out of obstacles with steep and slippery banks.

ROAD CONSTRUCTION IN BALUCHISTAN.

By CAPTAIN C. T. EDWARDS, R.E.

THE following short account of a small road-making job has been written for the interest of those who may not have served in Baluchistan, and for such assistance that it may give to anyone who may have to tackle a similar job in future.

In June, 1929, the author, who was at the time commanding the 21st (Field) Company, Royal Bombay Sappers and Miners, at Quetta, was ordered to construct a road fit for motor transport for 26 miles, between Maratangi on the Loralai–Fort Sandeman road and Gwal Haiderzai on the Killa Saifulla–Fort Sandeman road. The object of the road was to open up the somewhat inaccessible country which lies in the Daman Ghar hills separating the Loralai and Zhob valleys, and to provide an alternative and quicker route from Loralai to the centre of the Zhob valley.

The cost of the road was not to exceed Rs. 10,000, which was to include all charges for transport, explosives, hire of lorries, compensation, and a small amount of working pay per man to compensate for undue wear and tear of clothing. The time available was 2½ months, being the period available between the end of the spring training camp at Hanna and the autumn collective training season. The time of the year was the hot season in the Zhob valley, when the maximum day temperature at 4,500 feet runs up to some 106°F.

On June 1st, therefore, the Officer Commanding set off for Loralai, and on June 2nd and 3rd rode up the suggested road alignment with the Garrison Engineer, Loralai, and a cavalry escort. An adequate reconnaissance of 26 miles of road alignment in two days was a somewhat difficult undertaking, involving as it did simultaneous reconnaissances for the general line, and also more detailed estimates for the time, cost and labour required for the chosen alignment. It could be seen, however, that the road could be constructed within the time available, but that Rs. 20,000 would be required to allow for the large amount of explosives necessary, and also for the hiring of some 120 local labour to assist in the easier clearing and levelling.

It will be realized at once that the construction of a *pukka* metalled road for 26 miles in 10 weeks was out of the question, the M.E.S. estimate for such a road in fact being about Rs. 3 lakhs. All that could be attempted was to make a reasonably good formation level 14 ft. to 18 ft. wide, choosing the easiest places, such a road being gravelled and part-soled later by coolie maintenance gangs.

A word here as to the characteristics of this part of Baluchistan and of the usual methods of road construction would not be out of place. The country generally is very dry, the soil, except in the cultivated portions of the valleys being hard *patt*, covered with loose stones. This, in dry weather, is extremely hard, but breaks up into dust under traffic, while after rain it is very soft. The hills are all steep and rugged, and are largely formed of stratified limestone and shale, which has been weathered and folded in many places to fantastic crags. There is normally no surface flow of water, but during the rainy season in July and August, violent storms in the hills cause sudden and copious spates in all *nullahs* and folds of the ground. These *nullahs* or water-courses are very numerous, especially near the bases of the hills, and vary in depth from 3 ft. to 30 ft. and in width from a few yards to several hundreds. The larger *nullahs* are invariably bottomed by water-worn shingle.

The general drainage system, as is frequently the case in Baluchistan, is at right angles to the general line of hills, and where the water-courses break through the hills, deep narrow *tangis*, such as that at Maratangi, are the result. In the broader valleys there is a certain amount of cultivation on the flat sandy stretches, but the lower slopes of the hills are everywhere rocky, hard and much cut up, being in fact usually marked in the map as " stony waste."

Roads are neither elaborate nor very good, as distances are large and the traffic relatively small, but in good weather they offer reasonably fast travelling for well-sprung cars. Where roads traverse the stony *patt* on the more level portions of the valleys, they merely consist of a gravel surface on a varying amount of soling between two side drains, the formation level commonly being raised a foot or two above the general surrounding level to assist in drainage. When the road requires repair, more gravel is laid down by maintenance gangs, which is in time rolled in by the traffic. Where it is necessary to cross *nullah* beds, the road ramps down to the level of the *nullah* bed, the bed is cleared, and the road ascends again by another ramp on the far side. After rain the *nullah* beds invariably change their shape to some extent, and the ramps are eaten into. Maintenance gangs are therefore kept busy during the rainy season.

Local irrigation consists in many places of *vialas* (small open water-channels) and *karaises* (sloping tunnels bringing water from the hill bases to the more level plains), but where these do not exist, the villagers depend upon the intermittent flood water from the hills, which they guide down between *bunds* to the cultivated portions, and divide among their various fields. These *bunds* are apt to cross the road in places and where they do so the flood water naturally damages the road.

The road which the company was to construct was of the above type except that, as has been explained, only the formation level was

to be completed, leaving the surfacing to be done later. The country to be traversed, however, was considerably more difficult than that traversed by the majority of roads, as the route wound its way among the tangle of hills, up to nearly 7,000 feet, which formed the Daman Ghar range.

The proposed alignment for the first two miles climbed slowly from the Fort at Maratangi over generally smooth *patt* to the *tangi* where the Mara Rud debouches from the hills. After this for a mile the choice lay between laying the road in the *nullah* bed itself, or side-cutting along the rocky hillside. As the floods in this part of the *nullah* were evidently severe, the former proposition was obviously impracticable; and the alternative entailed heavy side-cutting in rock up to 40° slope.

For the next five miles the route lay up the narrow gorge of the Mara Rud. For the most part ledges or terraces existed above flood level, where it was possible to make the road without undue labour, but it was also necessary to cross the main *nullah* some seven times, to avoid the rocky outcrops, which formed precipitous cliffs at intervals on alternate sides. In this five miles it could be seen that work would be heavy, involving much clearing and levelling and cutting of ramps in and out of the main and many side *nullahs*.

For the next 10 miles, between Sabra and Bharat Khel, the route chosen lay up the left branch of the Mara Rud. This portion presented no difficulties, as the valley was everywhere broader and shallower than lower down, leaving plenty of room for the road on the higher portions well clear of the river-bed.

The last nine miles from Bharat Khel involved the descent from the watershed at 5,650 feet at mile 20 into the Zhob valley at 5,000 feet, and contained 2½ difficult miles among the chaos of small spurs, *nullahs* and crags, which decorate that choice part of the world.

The job presented a few elementary problems of principle and administration, as does any job which departs from the normal routine, and which had to be solved as a result of the preliminary reconnaissance. These were briefly as follows :—

(1) *Where to Start?*

The answer, Maratangi, was fairly obvious, as we were to be based on Loralai, and the Zhob valley light railway from Khanai could not cope with our mule transport, had we desired to start from the Zhob end.

(2) *Water.*

At the time of reconnaissance, water was very scarce throughout the proposed alignment, the only water existing being as follows :—

(*a*) A *viala* of about half a cusec started in the river-bed about four miles north of Maratangi and flowed down past the Fort there.

(*b*) At Sabra were pools in the *nullah* bed, and a very small *viala*.
(*c*) Between (*a*) and (*b*) were a few small pools in the *nullah* bed.
(*d*) At Danda was a pool in the *nullah* bed, of poor quality.
(*e*) At Bharat Khel water was fairly plentiful, as there were four springs (all rather salty).
(*f*) At Wulgai Kalai was a well, and a spring which was at that time dried up.
(*g*) For eight miles between (*e*) and (*f*) water was non-existent, the spring marked at X near mile 20 being dry.

As the company and attached transport numbered 320 men, 180 mules and 70 camels, the importance of an adequate water supply will be appreciated. As things turned out, however, the rain in July eased the water situation considerably. Pools formed in the *nullah* bed at Bharat Khel to water animals, and spring X filled two small wells which we dug there. A 12-foot well at Sharan China also yielded an ample supply of good water.

(3) *Camping Sites.*

This was largely governed by (2) above, and by the fact that it was obviously uneconomical to camp more than four miles from the site of work. Furthermore, the route was impracticable to all except pack transport until the road was made, and frequent moving of the camp would involve unnecessary waste of time.

It was decided, therefore, that the first main camp should be pitched at mile 2 by the *tangi* just above Maratangi, near which a lot of the hard work was situated. From here, one section with some coolies was to be sent forward to intermediate camps—to be maintained by pack—to complete the easier portions of the route up to Bharat Khel.

On the arrival of the road at Bharat Khel, the main camp for headquarters, one section, and attached transport, was to be pitched there, while two sections were to be sent forward—again to be fed by pack—to complete the more distant portions of the road to Gwal Haiderzai.

(4) *Transport.*

This was arranged for by the attachment of some 80 A.T. carts and 70 camels from the S. and T. at Loralai, the latter being intended for the forward moves of detached sections, and their supply. A few riding camels were also included, which proved most useful for reconnaissance and messages. The A.T. carts also provided the supply column to Loralai, which was 28 miles distant from Maratangi camp, and 45 miles from Bharat Khel. This I.A.S.C. detachment of 250 animals and some 120 men was under one P.M.* Jemadar

* Punjabi Mussulman.

—Muzzafar Khan—who put up an extremely good show. Their efficiency and animal management was first-class, and may be accounted for by the fact that the A.T. companies at Loralai invariably spend some 25 days per month on the march with convoys between Harnai, Loralai and Fort Sandeman. Their speed at pitching camp had to be seen to be believed.

(5) *Rations.*

These were sent by convoy from Loralai every ten days, vegetables and meat being supplied by local contractors.

(6) *Explosives.*

A small supply of explosives was obtained from Fort Sandeman, and some 13 cwt. dynamite and 5 cwt. powder wired for from Karachi. The latter arrived in due course, having been passed on with the utmost dispatch by all who had to handle it *en route*. Its final arrival at Loralai is worthy of mention. Its arrival at Harnai having been duly notified to Loralai, elaborate arrangements were made for its safe transit to the latter place. The stationmaster, Harnai, however, had no intention of keeping such stuff in his premises, and packed the whole lot into the first ramshackle lorry he could get, and sent it off at once to Loralai. Here it was discovered at 3 a.m. next day, lying unattended in the bazaar, by the police who had been sent off to find it.

The company left Quetta on June 15th by rail for Harnai, where we spent a torrid night, and picked up our rations, forage and some 60 A.T. carts which had been sent down to us from Loralai.

The first and second days' march to Loralai lay up the Dilkuna pass, which climbs in 21 miles from 2,900 feet at Harnai to 7,500 feet at Ashgara. The road, which was built many years ago by the P.W.D., is a very fine one, well graded and drained, but for the most part only wide enough for single traffic. It winds its way through narrow gorges, is cut out of the side of the vertical cliff in places, and clambers up the steep hillsides in others, the interest of the climb and scenery well rewarding one for the exertion of the march.

Loralai was reached after four days, and after a day's pause to draw supplies, forage, tentage, tools and more transport, Maratangi was reached on the 22nd June. This was the hottest time of the year, but marches were started at 5 a.m. and all ranks usually settled down in camp by 12.30.

The general line having been settled on the preliminary reconnaissance, it only remained to fix the detailed line and mark the actual site. This was done on the flat by stone *burgis* at 10^{x} interval, and on hillsides by marking the cutting edge with whitewashed stones, the grade having been taken with a pocket level.

Work was started on the 22nd June, as follows :—

(1) Two sections working from the Headquarters Camp at Maratangi began the portion between miles 2 and 7. This portion included nearly a mile of sidecutting in hard rock inside the *tangi*, which occupied one section for three weeks.

(2) 50 coolies in gangs of 10 each, with a Sapper overseer, were sent to clear the portion between miles 0 and 2.

(3) One section, with 70 coolies, also in gangs of 10, was sent forward to Sabra from where they completed the portion from mile 7 to mile 16½, moving camp later to Danda as their road progressed.

Work was done daily between 05.00 and 14.30, with a break of one hour for breakfast ; the parties thus arrived on the site as early as it was light enough to work.

Work progressed with little interruption up to 21.7.29, by which date the road was completed as far as Bharat Khel, whereupon headquarters and two sections and attached transport moved up to Bharat Khel.

The nine miles north of Bharat Khel to Gwal Haiderzai were attacked as follows :—

No. 1 Section was sent forward on 23.7.29 to Sharan China to construct that portion between the main Zhob road at mile 26½ and mile 23½. This section had attached to it the 70 coolies who were retained for the second month. In order to ensure a supply of water, the section had at once to dig and line a 12-ft. well in the *nullah* bed near their camp site. The small well which already existed was not fit to drink as it was fouled and full of leeches.

No. 2 Section, having completed the portion in the *tangi* at Bharat Khel, was moved forward on 25.7.29 to the spring marked X at mile 21. As the spring was dry, it became necessary for them to dig two wells, which at first yielded so little water that their supply had to be augmented by water sent on pack from Bharat Khel. Fortunately, after three or four days, the advent of rain eased the situation considerably.

No. 3 Section, working from the main camp at mile 16½, completed the portion between Bharat Khel and mile 21. Both this section and No. 2 had a lot of hard work side-cutting for the first 2½ miles of the descent into the Zhob. No. 3 Section, in addition to their seven hours' digging daily, for most of the time had a march to and from work of three miles.

After 28.7.29 work was somewhat hindered by rains, which, however, had the effect of softening the ground and making it much easier to work in. The portion of the road which had been completed was also rather cut up by the A.T. carts bringing up supplies and

Photo 1.—The raw material.

Photo 2.—The finished work.

Road construction in Baluchistan 1-2

Photo 3.—Laying "armco" culvert in concrete in side nullahs at mile 21¾.

Photo 4.—Transport crossing main nullah bed at mile 4¾. Here "clearing and levelling" only was required.

Road construction in Baluchistan 3-4

mails and necessitated a good deal of maintenance. On several occasions, the main *nullah* below Sabra being in spate blocked the road which crossed it at intervals, and thus closed it for 24 hours at a time. On one occasion the ambulance *tonga*, complete with malaria patient, was cut off between two crossings, and had to remain there for 24 hours. The ration convoy, however, fortunately got through on all occasions.

That portion of the road between Bharat Khel and Gwal presented no undue difficulty, except the portion of 2½ miles immediately north of the watershed. Here the rugged formation of the ground rendered a lot of blasting and cutting work necessary, and the placing of concrete culverts over deep side *nullahs*, which were too hard and deep to ramp.

The coolies were employed wholly on clearing and on the easier digging portions, being provided with tools by the company. They were poor specimens and had little idea of a good day's work, being content at first to work three men to a shovel, two pulling with strings and one on the handle. A short spell of digging drill, and the fiat "one day's pay per shovel" soon, however, produced an improvement. As the Maratangi coolies were not able to work in the area north of Sabra, only 70 coolies were employed for the second month's work.

The coolies gave little trouble apart from their disinclination to work, though on one occasion one coolie found it convenient to move to Loralai for a space while his son, whom he had stuck in the ribs with a knife at Bharat Khel, recovered from his injury. Our S.A.S.* attended to him and other complaints, and also to those of a few local worthies, with the result that on one occasion John, the junior subaltern, was rather overwhelmed with requests from the local beauties of Sabra to be cured of all manner of maladies.

The company was rather troubled by sickness with malaria and stomach troubles. The Zhob in July and August is a bad spot for malaria, and the heat and dust together conspired to cause a lot of stomach trouble. Altogether, over 50 per cent. of the unit was down with sickness for various periods, and, even a year later, men were still troubled with relapses of Zhob malaria. There appeared to be no absolute preventive for this malaria; mosquito nets are useless in 160-lb. tents, and even the use of bamber oil and quinine in large quantities does not prevent it. The mosquitoes breed in the running water of the *vialas*, and only a thorough disinfection of these would have been effective.

The road was completed on 16.8.29, and on 19.8.29 the company marched *via* Kalu Killa and Artakzai to Killa Saifulla, where we had an enforced rest of four days until 25.8.29, due to the Zhob valley light railway being washed out on both sides by abnormal

* Sub Assistant-Surgeon.

rain. Quetta was finally reached on 26.8.29. The mules, accompanied by the attached transport as far as Loralai, had a return march of 120 miles to Harnai, from where they were railed to Quetta, arriving on 29.8.29.

A few figures as to the work done will be of interest.

(*a*) DISTRIBUTION OF MAN-DAYS.

No. of working ranks	171
Total days on site	55

Item.	*Man-Days.*
On the work (47 days)	5778
Holidays (7 days)	1085
Rain (1 day)	150
Sick	367
Guard duty (guards in three camps had to be maintained simultaneously)	658
Post orderly	67
Camp employ (this included 1 *mochi* on equipment and 3 blacksmiths sharpening picks)	705
Employed supervising coolies	235
Moving camps	160
Repair and maintenance after rain	200
Total man-days available	9405
Percentage employed on construction	61·3%

(*b*) DETAILS OF WORK DONE.

	Yards.	*Cubic feet.*
Clearing	17180	
Clearing and levelling	21500	
Side-cutting up to 2′ cut...	3250	65000
,, ,, ,, 3′ ,, ...	1720	93300
,, ,, ,, 4′ ,, ...	730	45000
,, ,, ,, 5′ ,, ...	310	24600
,, ,, ,, 6′ ,, ...	220	17000
,, over 6′ ,, ...	130	21000
Ramps and cutting	1920	112000
Total distance (26⅛ miles)	46960	
Side drains, 3′ wide 1′ deep	1500	3000
Catch-water drains, 3′ wide, 1 deep	12500	25000
Total excavated		405900

Notes.

(1) Side-cutting includes some 1,800 yards dry rubble retaining walls 1′ to 3′ 6″ high.

(2) Some 40% of the side-cuts over 2′ were in rock, involving the expenditure of 3½ cwt. gunpowder and 9 cwt. dynamite.

(3) In addition to the above, 8 stone culverts over 1′ *vialas* and 2 armco culverts set in concrete were put in.

(4) Width of road was 18′ except in cuts, where the minimum was 15′.

(5) Sapper man-days on the work were 5,778 (see (*a*) above), therefore it will be seen that the average excavation per man-day was 70·3 cubic feet, as the coolies were employed almost entirely on clearing and levelling. This is in addition to culverts and retaining walls made, and the jumping of some 3,000 boreholes. The average march to and from work was 1½ miles each way, though the P.M. Section's average was nearly 3 miles.

(*c*) DATA OF INTEREST.

(A) *Rates of progress when side-cutting.*

When side-cutting with a cut of 5′ to 6′ (25° slope), the following rates were noted :—

(i) No rock : 6′ per man-day.

(ii) 25% stratified limestone and gravel, needing some blasting : 3′ per man-day.

(iii) Stratified limestone, all blasting and crowbar work : 1′ per man-day.

When retaining walls had to be built in addition, these rates were considerably lowered.

(B) *Explosives required per yard.*

(1) In (A) (ii) above, ¼ lb. dynamite per yard.
(2) In (A) (iii) above, 1 lb. dynamite per yard.

(C) *Explosives.*

In all kinds of rock and in soft shale, dynamite was more effective, and cheaper, than gunpowder, as the shattering effect, even if the rocks were not dislodged, enabled the rocks to be prised out easily with crowbars. Gunpowder invariably blew out of the cracks.

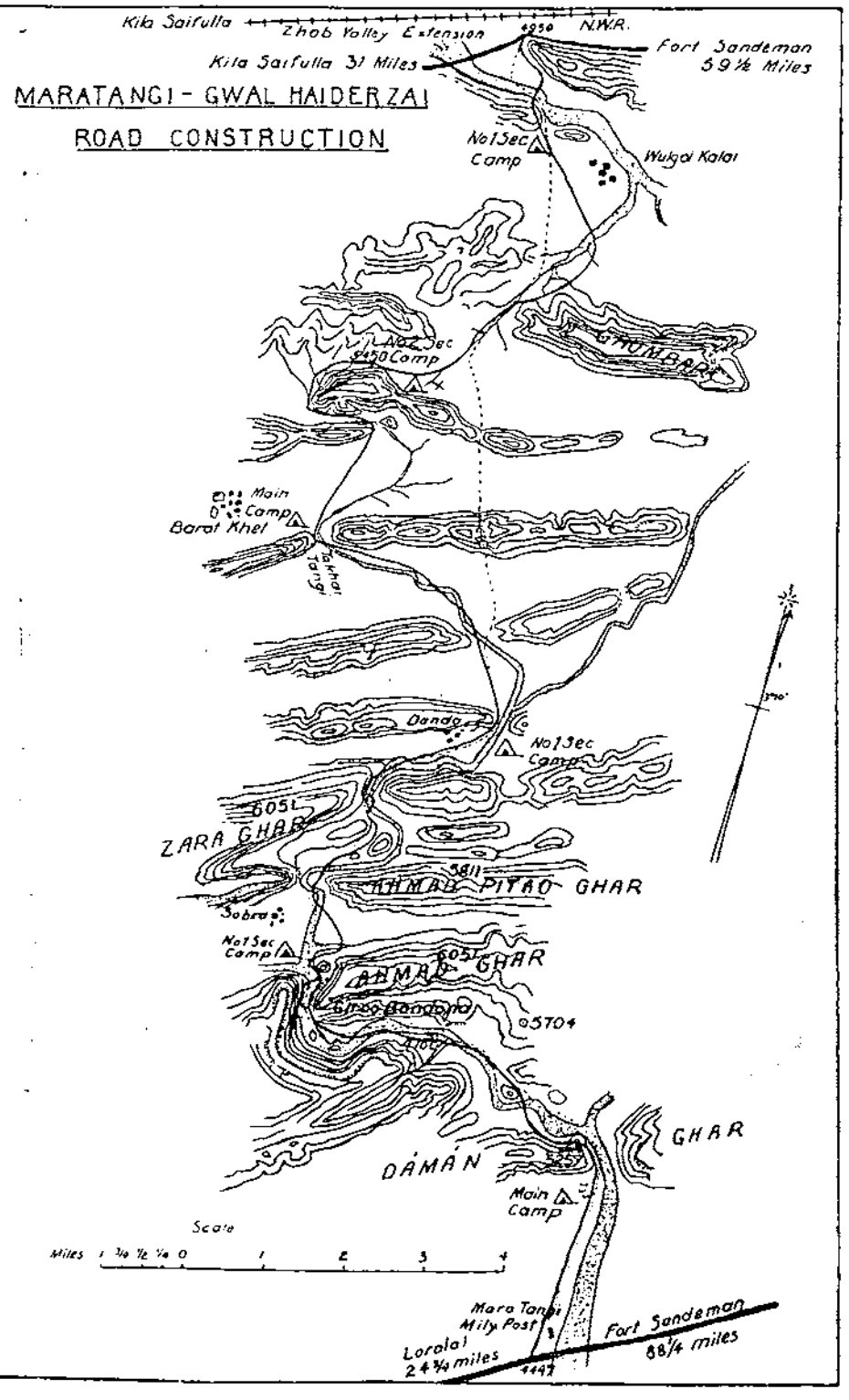
Technical matters of interest were few, the chief interest lay in the few administrative problems which, though simple, called for a certain amount of forethought. The self-contained section of the Sapper and Miner Company proved admirably organized for the work, one section being detached up to 12 miles for 2 months, and one section being detached for one month.

The dynamite used proved much more effective than country powder, both in stratified limestone and in hard shale, and was very reliable, no misfire occurring in over 3,000 charges fired.

A power drill, such as that issued to the 17th Field Company, R.E., at home, would have proved invaluable, seeing that over 3,000 bore-holes had to be jumped by hand, but the question of its transport is not easy. As it was, that portion of the road where most blasting was required was started ten days before wheeled transport could be got to it, so that for this period a compressor set on wheeled transport would have been idle. On the other hand, a pack set for camels, if such exists, would be liable to prove unreliable owing to frequent dismantling.

As regards the reconnaissance for such a road, much can be gleaned beforehand from the map. Pack tracks, even though they cannot be followed blindly, nevertheless give a very good general indication of the line to follow, and narrow the field of search. An estimate of time and labour can be rapidly made even by an inexperienced person, by working out beforehand the length of road that can be made in a day by one man for various slopes of side-cutting, and then judging the slopes by eye. One is apt to neglect drainage in an arid-looking country, but the provision of adequate catch-water drains and side channels is essential, even for the roughest track, or a lot of one's work will be wasted.

As regards its usefulness for the company, such a job naturally interferes considerably with normal training, and being really pioneer labour, does not afford much technical training. If not too often indulged in, it is, however, excellent training in general efficiency and the smooth running of a unit on service, and enables section commanders, particularly those who are detached, really to get hold of their sections.


Kila Saifulla
Zhob Valley Extension
4950
N.W.R.
Kila Saifulla 31 Miles
Fort Sandeman
59½ Miles
MARATANGI - GWAL HAIDERZAI
ROAD CONSTRUCTION
No13Sec
Camp
Wulgai Kalai
No12Sec
Camp
GHUMBARA
Main
Camp
Barat Khel
Tarkhar
Tangi
Oando
No13Sec
Camp
6051
ZARA GHAR
5811
AHMAD PITAO GHAR
Sobra
No13Sec
Camp
AHMAD
6051
GHAR
5704
GHAR
DAMAN
Main
Camp
Scale
Miles
Mara Tangi
Mily Post
Fort Sandeman
88¼ miles
Loralai
24¾ miles
4447

IN TUNE WITH THE EXAMINER.

By "MARK OVER."

MANY pens have prescribed the only straight road to victory over the examiner. Authoritative pronouncements by fortunate fellows in the first flush of a successful circumvention of the enemy have described the methods of their preparation; intricate programmes extending over many months, the exact allocation of every hour of the day and week have time and again been offered to the earnest student. All this is excellent. But a vital point is missed; what of the examiner? What do you know of him, you umpteenth failure? His ideas, his methods, his outlook are all things that are of vital moment to you, and here you are in front of your paper, your A.B.4, your map and your inkpot and ignorant of them all. Let me take you, disguised for the moment as a graduate and therefore on terms of easy *bonhomie* with this secretive man, and let us persuade him to explain and expand his system.

First of all, what manner of man is he, this old enemy; is he a bitter, crabbed and hoary old expert in whom the memory of youth has long since disappeared in a welter of disillusion? No, not yet, but he soon will be if he has to correct many more papers like your last one. As a matter of fact, he is in truth a very human brother-officer, who has passed not so many years ago through this self-same valley of tears, ready to do his best for you, eagerly searching for signs of knowledge however deeply hidden, anxious to give credit wherever credit is reasonably due, to find out what you do know rather than what you do not. He has, we trust, a sense of humour, but this is a quality which must not be too severely strained or it may turn to sour irony. But now let us see him setting about his task.

About the time when you are ruling sheets of paper with columns appropriate to the hours of intensive study in view, our friend the examiner is sitting with eyes closed, thinking. TIME SPENT IN THINKING IS RARELY WASTED. Let us imagine that the object of his thoughts is that open ditch into which so many fall, the tactics paper. What is he thinking? First of all, he will run over in his mind the general form that his paper is to take. Is it to be an advanced guard paper, with perhaps a question on the handling of a cavalry squadron, developing into an attack by the main guard? Or is it to deal with a rearguard, flank guard, the crossing of a river,

attack, defence? You will see that his thoughts run over the headings of definite operations as they occur in the training manuals, *F.S.R.*, *Infantry Training*, *Cavalry Training*, and so on. Having thus settled in his mind the general form of his paper, the operations of war and the arms of the service with which the various questions will deal, he then jots down the headings with a few notes on the composition of the force which will meet the case. Now comes the important part of the business. What are the principles which govern the action of the various arms and the force as a whole in the selected operation? He takes his *F.S.R.*, his *Infantry Training*, his *Cavalry Training* (knowing them by heart, of course, but it is necessary to quote chapter and verse), and makes a note of the main principles in each case.

To take a simple example, he may select counter-attack as a suitable subject. He searches the books, finds the following informative paragraphs and jots down :—

F.S.R., Vol. II, Sec. 82 (2).

(*a*) Object :—to assist some portion of the defence or regain some definite tactical locality of importance.
(*b*) Speed.
(*c*) Definite and limited objective.

Again, *Infantry Training*, Vol. II, Sec. 4 (2).

(*d*) Success dependent on the combination of fire and movement.

and Sec. 21 (9)

(*e*) Surprise.
(*f*) Previous study of ground.

This brings me to the first important point which the candidate should bear in mind when he picks up the paper The examiner has not seized the first available map, thought of a number, doubled it and wondered how he can produce a tricky problem on any old piece of ground. No, he sets out to test the candidates' knowledge of the principles laid down in the books for this particular type of operation of war. He has a very fair idea of the kind of ground which will most clearly bring out the points required and adapt itself to the problem. With the picture in his mind he searches, perhaps quite a number of maps, until at last he finds the very thing, or at any rate something very near it. He can now get to work on a narrative which will bring you and your select body of troops to the right place at the right time. Recognize then the nature of the problem; take your pencil and jot down the principles which you know, or ought to know, govern this operation, then examine the factors and especially the ground very carefully to see how the

principles can be applied in the simplest possible way. Do not seek some masterly Napoleonic manœuvre, the secretive march through miles of unreconnoitred woods to fall on the enemy's cookers. This may surprise him, but it isn't speed, and it won't surprise the examiner, it will merely displease him. He is no Napoleon and will not recognize you as such. All he wants to find out is do you, or do you not, know the principles laid down in the book, principles he has so carefully arranged his scheme to bring out. By the way, a word of warning: do not write out the principle at length and follow it up by some such remark as that, "in this instance, of course, it can't be applied because the ground isn't suitable. Of course I know that I must have a definite objective, but there doesn't seem to be one, so I am going all out"! It may seem incredible but this does appear quite frequently or, at any rate, something very similar. It means that you think the examiner rather an ass for setting the question in that way, and he, being human, retorts by looking on you as a hopeless case. You are very definitely out of tune.

This business of principles is infinitely important; it is at the root of all knowledge, and, for our immediate and sordid purpose, it is the main factor in mark-winning. No principles, no marks; good principles, poor plan, 50 per cent. anyhow; good principles, good plan, full marks. So much for principles at the moment, but we shall meet them again. One moral that may usefully be drawn from this matter, however, is that it indicates a very sound method of study. Take you rmanual, and one week study the Attack, general principles; infantry in the attack-principles; machine-guns in the attack-principles; artillery, tanks in the attack-principles. Work out for yourself a small scheme bringing out the principles you have noted from the book. Cover bit by bit each chapter of *F.S.R.* Work with another student, try your schemes on the dog.

Now let us get back to the study of the examiner at work. He has decided on the general outline of his scheme, on the bit of the map where the action is to take place, on the troops he wants you to handle, and on others which may be essential to the picture but with which he does not wish you to be bothered, or arms about which he does not intend to test you. He has now to weave all these varying factors into a coherent narrative and in this he is up against certain limitations. First of all, everything essential must be there; secondly, the paper must not be too long; thirdly, and this is no easy task, it must be so phrased that there can be no doubt about what is meant, what the situation is or any loophole by which the rabbit can bolt down the wrong burrow, followed by some 150 others; yes, diffidently it must be said, the paper must be fool-proof.

A few moments' thought, or better still, an effort to produce a scheme yourself, will soon show you that there is no room in the

narrative for any irrelevant matter. Apart from the introductory sentence, the general idea that NORTHLAND and SOUTHLAND are at war, every sentence of the narrative, every piece of information, is there because it is necessary. The wise examiner leaves as little room for "assumptions" as possible. The road to failure is paved with unfortunate assumptions.

The moral, then, is: weigh with care every sentence in every bit of information in the narrative, it is there for a purpose. If you read that the trees of a wood are so many feet high, or that fences are of wire in one place and thick in another, be sure that this is essential for the correct appreciation of the problem and not because the examiner is a botanist in his spare time. If you find yourself "as O.C. 'X' Coy.," the proud possessor of 30 lorries, a machine-gun platoon, and an anti-tank section in addition to the men with the *bundooks*, it is odds on that these things are provided for your use. The examiner wishes to find out if you know the principles of lorry, machine-gun or anti-tank handling. Do not, as so many do, say to yourself (yea, and write, too) "machine-guns are no use in this place, so I decide to leave them behind." This is definitely several semi-tones out of tune with the examiner. It implies that either (*a*) he is a fool to clutter up the narrative with useless information, or (*b*) "what a clever fellow am I to have seen through the trap." Now the examiner dislikes being thought either a fool or a knave. Really no self-respecting examiner sets traps for poor subalterns or captains, and to be accused inferentially of Machiavellian designs upsets him. It creates a bad atmosphere which may communicate itself to less offensive parts of the paper.

One final word about the narrative. Do your level best to get yourself well into the picture as O.C. "X" Coy. or "Y" Battery, or whatever post you are filling. Be quite certain you know what troops are under your command—it is extraordinary how often some get left out in the cold, particularly Sappers—where your troops are, what material you are given, what the time is and what you know of the enemy. If you are definitely told that your troops are in a certain place or on a line A—B, don't *assume* that they are somewhere else. This is frequently done and is the royal road to failure. And speaking of the enemy, because he is said to be in one place, it does not follow that he might not be in other places as well. This has been assumed in war with disastrous results. The examiner will tell you as much of the enemy as you would be likely to know in war and no more.

And now for the questions themselves. How does the examiner approach them? They are indeed the most difficult part of the whole business. How many are there to be? What length of answer is to be expected or required? How to frame them so that they do not admit of too lengthy or too varied solutions? He has

now to remember that your time is limited and that the time is coming when he himself is faced with a pile of books, A.B.4, 200, 300, 400, to be corrected *in his own time*. Don't forget that, young feller, when the ink is running too freely. All these to be done in his spare time. The question that admits of an answer giving the most information in the fewest words suits you both, or should do. Remember the examiner has set out to find whether you know certain things and he sets the questions accordingly. It is not, therefore, desirable to throw out a sort of smoke screen of the masses of things which you know (and are not asked for) in order to hide deficiencies in the things he is really interested in. Here let me say quite simply that PLAN means PLAN, ORDER means ORDER, and APPRECIATION means APPRECIATION. If you are asked for a plan, don't spend four pages writing an appreciation. If the examiner wants an appreciation he will say so. There was once a candidate who was asked, "As O.C. 'B' Coy., your plan of attack." Five closely-written pages of detailed appreciation concluded triumphantly, "Plan: To attack and gain the company objective." Marks, 0/100. I do sympathize; it is very hard, here have you been hard at it for months writing appreciations and never a one in the paper. Surely the examiner must have made a mistake, he must have disguised it somehow? Down it goes, two, three, four pages. No good. I feel you are saying to yourself, "Anyway, I don't do that." Look round the room; see all those fellows scribbling? Forty, fifty, sixty per cent. are writing orders when asked for a plan, a plan when asked for an appreciation, so frail is human nature. Be careful. This, however, must not be taken to mean that you should not make notes. By all means make very brief notes in pencil on the left-hand page to help you to appreciate the situation before you set out your plan. But here again, steer clear of wasting time by writing out the whole of a long answer in pencil on one side of the paper and then copying it out verbatim on the other side in ink.

And now map reading. You may, or may not, be given a direct question on this subject. Remember, however, that the examiner has very carefully selected the ground for the scheme; it follows that careful map reading is essential on your part in every tactical problem. To recognize what ground is open, what is screened from positions that are, or may be occupied, by the enemy, by trees, or by the curvature of the ground, what ground is likely to be boggy and therefore an obstacle to tanks, all these points have been considered by the examiner and must receive your attention, too. Be wary of ring-contours, they may be but swellings in the ground behind which brigades of artillery cannot be drawn up in mass invisible to the enemy, and over which that personal reconnaissance in the semi-prone position will expose your own ring contours to the enemy observer on Pt. 549.

It is usual to find in a tactics paper a question on the subject of Administration. It is hardly too much to say that 75 per cent. of candidates are uncertain where administration begins and operations end. "As O.C. 'B' Coy. on outpost duty, what administrative arrangements will you make for the night?" It is odds on that a majority of fellows will include such items as "construction of fire trenches," "alarm signals," and so on, in their replies. It is an error of judgment, and loses marks, to put down all the things that O.C. "B" Coy. will do in the hopes that the examiner will select the ones which really interest him. You may include in the list all the things required but you show that you do not know what is meant by Administration. Again, an all too familiar answer is: "Arrange about rations (water, wounded, etc.)." What the examiner wants to know is what *are* the arrangements which you will make to get the water, rations, ammunition, and so on, to the troops. Where is the cooker to come to, and how does it get there: and here again it is not sufficient to "tell the C.S.M. or C.Q.M.S. to 'carry on.'" Your wounded have to be properly provided for and your dead buried. Something has to be done; what? Is 5 Pl. to feed first and then relieve 6 Pl. and so on. This is the kind of information that is wanted, neatly tabulated (*a*), (*b*), (*c*).

Last but not least we may get some useful hints if we look in on our examiner when he is in process of marking the papers. Does he go steadily ahead marking as you might say "by eye," estimating the comparative merits of Q.1 by candidates Nos. 201, 202, 203, and so on up to No. 497. Not he! Only a superman could carry all these comparisons in his head. The ordinary man will very soon be turning back to have a squint at No. 204, just to see whether No. 224 is really as much worse as appears at first sight, and very soon confusion will be worse confounded. No! Method is essential. Take Q.1. "As O.C. 'B' Coy., plan of attack." O.C. "B" Coy. is the proud possesser of a machine-gun platoon, a section of light artillery, an anti-tank gun—the narrative has mentioned that the enemy have tanks in the neighbourhood. Marks, 100. Our friend the examiner will allot perhaps 25 marks to the rifle company plan, 25 marks to the machine-gun plan, 25 marks to the artillery and 25 marks for the presentation of the plan as a whole, including allowances or disallowances for spelling, writing, verbosity, map reading; this is his marks reserve. By some such method only is it possible to maintain an even standard of marking throughout a large number of papers. It is worth your while to remember this; leave out your artillery and bang go the artillery marks, beyond recall; leave out your lorries, your Sappers, your tanks; 25 more of the best hopelessly down the drain. Ponder these things.

One parting thought. The examiner is at heart a sporting fellow; let your motto in dealing with him be: "Form at a glance"!

THE SIERRA LEONE SURVEY.

By CAPTAIN P. F. WHITE, R.E.

A FEW years ago a paper appeared in *The R.E. Journal* about the survey in the Malay States. This paper describes another and a different class of survey, and is written in the hope that some of the many R.E. officers now on survey duties will also write their experiences. A survey officer's work takes him more off the beaten track than does the work of most other Government officials. His experiences are sometimes more interesting in that he meets the natives as they are and not all tuned up for an official visit.

The Topo. Survey of Sierra Leone, with which this paper deals, was originated in 1925, by Colonel Rowe, of the Gold Coast Survey Department, who brought with him some Gold Coast surveyors to set the thing going. The Director of Surveys in Freetown was in charge of the Cadastral Survey of Freetown and the Topo. Survey of the Protectorate. The Colony of Sierra Leone was surveyed about twenty years ago. The Colony is only the small peninsula comprising the hills behind Freetown, while the rest of the country known as Sierra Leone is a Protectorate.

The physical features of the Protectorate may be divided into three belts, running roughly N.W. and S.E. The coast belt is mainly mangrove swamps and muddy creeks connecting the estuaries of the larger rivers. Long lagoons, separated from the sea by sandbanks, are formed by the strong tides running up the coast from the south-east. Behind this is a low, flat plain about 150 miles across, which, with the exception of a few isolated hills, does not exceed 350 ft. above sea level. From this plain rises abruptly the hilly country of the N.E. and E., where the general level of the land is over 1,000 ft. and many individual hills rise to over 3,000 ft., one peak reaching 6,400 ft. Large rivers rise in these hills, but as they are quite unnavigable for more than a few miles from the sea, they impede rather than help communications. There are a large number of smaller streams, so that, although many of these are seasonal, water is plentiful.

With the exception of certain areas in the south and west, the vegetation is very dense. The tall elephant grass of the north merges into bush in the south and, in some parts, into true forest. Nearly all travel is done on foot along bush paths which, in spite of many small windings, lead amazingly direct from village to village. Some of the more frequented paths have been broadened out into

hammock roads along which the Europeans usually travel. The rivers if not fordable are bridged. A felled tree suffices for the smaller streams, while a most ingenious suspension bridge made out of creepers is built across the larger rivers. Crossing these in a hammock is very nerve-racking, although the carriers' sense of balance is almost perfect.

One of the great joys of the survey was that more often than not the surveyor avoided these bigger roads and investigated the smaller paths. In several cases villages were visited whose inhabitants had never before seen a white man.

There is a 2′ 6″-gauge railway from Freetown and a network of roads is gradually linking up all the District Headquarters and the towns of important chiefs. This it is hoped will stimulate trade, which at the present time is in a very bad way.

The peoples are many and varied. Fifteen languages are spoken as well as many dialects. Fortunately, the native is a good linguist and enjoys travelling. The vernacular is a pidgin-English, which the natives appear to pick up easily. The European will seldom find that he is without anyone in his camp who can act as interpreter.

The existing maps of the Protectorate of Sierra Leone were compilations made at the War Office from travellers' diaries and political and R.W.A.F.F. officers' reports. They often erred by as much as ten miles and showed very little detail off the main routes. They showed either no levels at all, or, in a few cases, formed lines which were most misleading. When this survey began, a school was started in Freetown to train Africans as surveyors. The results produced were most satisfactory. The first class of pupils came out into the field after about twelve months' training and the junior class a year later. They all returned to the school from the end of June until the middle of October each year, when their memories underwent a much-needed refreshing. For the first two field seasons and a part of the third, Europeans were doing actual survey. Gradually this was left more and more to the Africans, while the Europeans did the compilation, and so kept a check on accuracy and produced a more uniform result.

The methods of survey employed were of the simplest, as cheapness was essential, but the accuracy obtained was more than sufficient for what was required by users of the map. The overall cost, including reproduction at Accra, did not exceed the estimated £2 10s. per square mile, and for this sum a survey was produced which has already been of great assistance in road locations and inter-tribal boundary disputes.

The country was divided into 111 sheets with sides of 15′ of arc, so as to conform with the International I/M map of the world. The scale adopted was 1/62500, and it is hoped that a 1/250,000 (¼″ to a mile approx.) reduction will shortly be produced.

This will be of greater value to travellers, but so long as the present trade depression lasts, lack of funds will preclude its production. A wall map of the whole country has been produced and is now on sale in England.

The survey was based on Astro-Radio points fixed near the corners of the sheets. These points were computed from the means of five pairs of observations, and it was estimated that the error in the position of any point did not exceed 100 feet. The original W/T set was a "Burndept Special." For the last two seasons a new Marconi set was bought which, having a frame aerial, was much more convenient. The phasing unit was never used, as atmospherics seldom interfered sufficiently seriously with reception to justify the carriage of the extra weight. Observations were made with a 5" micro theodolite by Cooke, Troughton & Sims. The points were marked on the ground by cement pillars with an inverted "Sparklet" bulb embedded in the top. These pillars were set up in pairs, about 100 feet apart, in case of damage to either, and it was impressed upon the village headman that dire results would follow any neglect of these "stones." It was found that, allowing for trekking, bad weather, etc., one point per week was a very fair average throughout the season. The cost was about £40 per point.

An Anglo-French Boundary Commission, in 1903, had determined the 13th meridian west from Paris by the method of carrying chronometers. This meridian was found to be in error by about 3′ of arc; and it is rather a curious coincidence that a recent expedition to the Aïr Plateau in French Soudan (Rodd, 1927) found an error of from 4′ to 6′ when comparing their W/T results with the original fixings.

The nature of the country, and the funds available, made traversing the only practicable method of survey. Three types were used: (1) Tertiary Compass Traverses, (2) River Traverses and (3) Rope and Sound Traverses. About 400 miles of traverse was done in each sheet of which 10 per cent. was T.C.T. This allowed a diagonal between two Ast. points and a tie, for sag, to a third. In some cases it was found possible to reduce this amount of T.C.T. when a river ran diagonally across a sheet. A normal average for T.C.T. was 1½ miles per day, and often considerably less, against about 5 miles of R. and S. It was essential, therefore, to curtail the former as much as possible. Long "legs" on the bush paths were few and far between. An average for a day's work was often less than 100 feet. T.C.T.s were plotted in the field at 1 : 12,500 and subsequently reduced. A closing error of more than 500 feet was not normally permitted. All large rivers were traversed, usually by Rope and Sound methods, along a bank. Where the nature of the banks did not permit this, the traversing was carried out with a Barr & Stroud rangefinder in a native dugout canoe—a somewhat precarious operation. River traverses were

plotted in camp at 1 : 12,500 and reduced. After the T.C.T. framework, the field sheet was further broken down by R. and S. framework traverses until blocks of about 20 square miles were left. These were filled in by R. and S. detail traverses sufficient to fix every village, and to enable the surveyors to put in intervening detail by eye.

The rope used was 310 ft. long but the distance plotted was 300 ft. This allowed for bends in the path and proved a very fair allowance. In river traverses the rope man "cooees" at each rope length; but for road traverses the length of a "cooee" was increased to three rope lengths. R. and S. traverses were plotted in the field direct at 1 : 62,500.

The field sheet, mounted on zinc, was first graticuled at H.Q. and the Ast. points plotted. It was then sent to the camp or group officer, who plotted the T.C.T. and R. and S. framework. From this he was able to give tracings of blocks to his surveyors for completion. As these blocks were surveyed they were plotted: and eventually the completed sheet was sent to H.Q. to be checked. After a further check at Freetown, the sheet was sent to Accra in the Gold Coast for printing, the proofs being checked at Freetown before the sheet was published.

With every sheet certain records were compiled by the surveyors, and subsequently stored at Freetown. They consisted of:—

(*a*) *A Field Sheet Record Book.* Containing a description of the country in the sheet and its survey, and a list of the other records.

(*b*) *Auxiliary Sheets.* These were the actual pieces of paper upon which the traverses were plotted in the field.

(*c*) *Village and River Field Books.* In which each surveyor recorded all relevant information about the villages he passed and the rivers he crossed. Each river, village and hill was numbered, this number only appearing on the field sheet. Village, etc., lists were compiled from these books and the spellings checked and standardized in collaboration with the political officers. The list of "Accepted Spellings" accompanied the sheet to Accra. The R.G.S. II system of spelling was used.

(*d*) *Traverse Slip Books.* Recording the particulars of the traverses and the barometer height adjustments along them.

(*e*) *A Tracing.* Which was made in case the original sheet got lost at sea or damaged to such an extent that it became useless.

All books and auxiliary sheets were numbered serially to simplify references to them.

The bases of the heights were the railway and road bench mark levels reduced to Colony datum. Lines of instrumental levels were

Travelling by hammock.

Carriers on a bush path.

The Sierra Leone survey 1-2

A Native Surveyor.
(With Major J. Dare and Brigadier H. St. J. L. Winterbotham.)

A Porro "Devil."

The Sierra Leone survey 3-4

run by the African surveyors between points of known height until a network was obtained such that no point was more than one field sheet distant from a line of levels. Every surveyor carried an aneroid barometer which he read at each station on his traverse (except on river traverses). These readings were adjusted for the daily wave of the particular barometer which was plotted by the surveyor over a period of three days. A number of baro. runs were carried out in each sheet from points of known height and mutually adjusted. In the traverse slip book were columns for these adjustments. Heights along the traverses were adjusted by the surveyors themselves between the various accepted heights obtained. For identification purposes, blaze marks were painted in red paint in villages and important road junctions.

The personnel originally appointed was augmented for the first season by two surveyors from the Gold Coast, and two officers of the West African Regiment; these returned to their own jobs at the end of the first season and a permanent staff carried on, consisting of the Officer i/c Topo. Survey, two European officers, a European Framework Officer and 25 African surveyors.

Once all the pupil surveyors got out into the field the organization consisted of two groups and a framework camp, the latter consisting of one European officer, one African booker, two headmen and about 40 carriers. Each group officer had two headmen and about 30 carriers. A group contained from two to four field camps, each run by an African, with three or four of his colleagues under him. Their output worked out at about five sheets per season for each camp. An African surveyor was allowed a headman and from eight to fifteen carriers, according to his job. A European had about ten personal loads and an African three. These numbers were very flexible, extra carriers being enrolled if occasion demanded. Labour was plentiful so that one could pick and choose and get rid of any idlers. All loads were carried on the carriers' heads. A man could carry up to about 150 lb., but for sustained work 60 lb. was a very fair load. With this load 15 to 20-mile-a-day marches were possible at an average pace of about 2 m.p.h., though some of the better carriers would travel much faster. As a European usually travelled at about 4 m.p.h., it was necessary to ensure that the essentials—a chair, table and drink box—should get off early, so as to arrive at their destination by the time they were required!

The carriers employed were all local natives, many of whom came back year after year. They were given a uniform—jumper and shorts—and ninepence a day. They were a most excellent lot of fellows and most trustworthy. From these carriers were selected rope and chain men to help on the traverses. They soon learnt the essentials of the job and became most efficient.

An indispensable adjunct to each camp was a court messenger.

The political officer in each district maintained a body of these men who did all police and official messenger duties. They represented the powers of law and order amongst the villagers and acted as go-betweens and interpreters for the surveyors. There is very great competition to get into this force, so that the men are the best possible and they are greatly respected by the other natives.

A field season lasted from early October to early July, the remaining months being too wet for field work. Early in June the camps returned to Headquarters and finished off the compilation and records of the sheets surveyed during the season. Europeans thus got a clear three months out of the country every year, kept fitter and could therefore work harder than the other Government officials who do eighteen months' tours.

It was found most satisfactory to bring out food from England. Any tropical outfitter would pack boxes to suit individual requirements and of such a weight that they were a man-load. It was found most convenient to pack "chop" boxes identically, so that the African clerk at Headquarters could not make a mistake when sending one out from store. Each box would last about one month. The country provided innumerable chickens, rice, eggs, a variety of fruit and vegetables and an occasional sheep or cow. All other essentials and luxuries had to be brought out tinned. A cook and house boy, generally assisted by a couple of carriers, attended to one's personal needs. There was usually great competition among the carriers for the assistants' jobs, as perquisites emanated from the kitchen.

A large double-fly tent with a verandah was provided, which, if carefully pitched in the shade, was most comfortable. In many villages, however, there was a political officers' rest-house which could be used by all Europeans. There was generally more room in these than in a tent to "spread out" for drawing. On arrival at a halting place, the local chief would bring a "dash" of chickens, eggs, and any other such things which the court messenger knew were wanted by the cook, and in exchange he received a money "dash" of equivalent value. This was a very easy way of doing the day's shopping! All eggs were carefully scrutinized by the cook before acceptance, and the bad ones returned to the chief before he received his "dash."

The job was most enjoyable, but would have been more so had recreational opportunities been greater. Game existed, both large and small. It was difficult to find, however, and not sufficiently attractive to entice out, after a long day, any but the most ardent *shikari*. Fortunately, there was plenty of work, otherwise boredom would have undermined one's health very quickly. Sickness, unfortunately, took a heavy toll of the Topo. Survey. Of the seven Europeans concerned, Lieut. P. B. H. Carden, R.E., died from black-

water fever, and two others were invalided home. The remainder, luckily, kept wonderfully fit, except for an occasional bout of malaria, or 'flu.

The climate, though probably not so deadly as in years gone by, has still to be respected. It is insidious, and undermines the vitality of those who do not make a great point of keeping fit both mentally and physically. With ordinary precautions, sufficient occupation to keep the brain interested, and plenty of exercise, sickness should be looked upon as bad luck rather than inevitable. The African was more often sick, or rather, gave way more easily to slight symptoms of sickness, than the European, simply on account of his fatalistic outlook on life. They were not greatly interested in their work except as a means of getting a livelihood. This trait appears to be inherent in the race, who, so long as they have enough food—or, at times, any food at all—are quite happy doing absolutely nothing. In the villages it is the women who work while the men talk! The Sierra Leone native is a most cheerful fellow and one soon gets very fond of him. The author of this paper enjoyed his time in Sierra Leone immensely, but left without the least pang of regret.

NOTE BY CAPTAIN V. E. H. SANCEAU, R.E.

Methods of attaching paper to zinc for field sheets:—

(1) Paper cut to exact size of zinc and pasted on.
(2) Paper cut larger than zinc and pasted on front and back.
(3) Paper cut larger than zinc and fastened to zinc, front and back, by a mixture of gum and paste.

Disadvantages of:—

(1) Paper started peeling off at the edges and after five years showed signs of wanting to peel off completely.
(2) Paper became detached from the face of the zinc, but not from the back, resulting in a drum effect, which varied with atmospheric conditions.
(3) The paper remained stuck on satisfactorily but presented a rather granulated surface to the draughtsman. This was, however, the most satisfactory method of the three.

SHIKAR IN UPPER BURMA.

By CAPTAIN A. M. GARNETT, R.E.

VERY little has appeared in print about big game shooting in Burma under present conditions, and the following account may be of interest.

I was to be stationed in Burma only for one year and desired to obtain particularly *saing*, *thamin* and *serow*. Expenses had to be kept to the minimum, and another difficulty was my lack of knowledge of Burmese.

The actual localities were decided upon after correspondence with the Game Warden, Burma, and the District Forest Officer concerned, both officers being very helpful. To overcome the language difficulty I engaged an Urdu-speaking ex-Sapper of Mandalay, named Maung Ba Sein, at Rs. 30 per month. My Madrasi bearer, Perumal, functioned as cook, and to complete my staff, I took my Madrasi orderly, Vellayan, a keen *shikari*. He acted as gun-bearer, gun-cleaner and general handyman.

Supplies are practically unobtainable in the jungles of Burma, and one has to travel self-contained. I laid in a two months' supply of everything required, obtained partly in Rangoon and partly in Mandalay. What to take is a matter of personal taste and experience ; for instance, I ate plain biscuits instead of bread.

Eggs and fowls can sometimes be bought, but a supply of tinned meats and fish is essential, as one cannot depend on keeping one's larder supplied with the rifle and gun. Shooting can sometimes be done from forest or P.W.D. rest-houses, but it is best to be independent. I took a double-fly 40-pound tent for myself and another for my servants. Water, of course, is obtained locally and must always be boiled before use.

The best time for big game shooting in Burma is from mid-April to mid-May. By this time fires have been through the jungles and they are in consequence open, and not thick with undergrowth as is the case after the rains. Also new green grass is beginning to appear as a result of the early showers.

My first camp was in the foothills of the Mogok district. I embarked at Mandalay on the evening of April 22nd in the Irrawaddy Flotilla Company's steamer *Taping*, and spent a hot, stuffy night. The ship set off at dawn with much clanging of anchor chains and nosed her way upstream, a lascar continually taking soundings with a long bamboo.

Thabeitkyin, the port for the Mogok district, was reached at 3 p.m. and we disembarked. I had written previously to the local Forest Ranger, and his clerk had a bus awaiting me and helped to tranship my baggage. The bus took self, servants and kit ten miles up the Mogok road to Wapyudaung, where I spent the night in the P.W.D. rest-house. The local Forester and two trackers were awaiting me here. Maung Tan Bu, the senior tracker, assured me that I should obtain *saing*, bison and elephant within ten days, and he arranged for two bullock carts to be ready next morning to transport my stuff to camp outside his village Onzon, four miles off.

I left Wapyudaung at 5 a.m. with Vellayan and the trackers, leaving Perumal and Maung Ba Sein to bring along the kit. I did a *chukker* through the jungle, seeing a couple of wild dogs and a barking deer, known as *gyi* in Burma, reaching Onzon at 11 a.m. The kit arrived about the same time and I pitched camp in a bamboo glade on the opposite side of a stream to the village. In the evening I wandered through the jungle close to camp and saw two *gyi*, one of which I missed with the ·300.

I spent the whole of the next day from 5 a.m. to 6 p.m., Friday, 25th, hunting for *saing* in the forests south-west of Onzon. I put up a *saing* in thick bamboo cover and did not see him. I next came upon two cow *saing* feeding and did not disturb them. A little later, I spotted a herd of *saing* a hundred yards away, some feeding, others lying down. Through my glasses I made out a bull amongst those lying down, but he had a poor head, so I went on my way, and the herd decamped. Numerous *gyi* were seen, and the tracks of tiger and panther in the sandy bed of a *nullah*. At noon we reached a fair-sized stream with clear, running water, and halted for two and a half hours. I bathed, drank gallons of the water from the stream and had tiffin. Clear running water in the jungle appears to be safe to drink, provided there is no human contamination just above, as I suffered no ill effects on this or on later occasions.

I set off again at 2.30 p.m. and put up a *sambhur* hind and a solitary bull *saing* in fairly thick, unburnt jungle. The *saing* stood broadside on, thirty yards away, for half a minute. I could not judge the size of his head as it was obscured by the undergrowth, so did not fire. He then crashed off. At 4 p.m. I saw another solitary bull *saing* in open teak jungle. I took the ·470 from Maung Tan Bu and approached to within ten paces of the grazing *saing*. He was a young bull with thin horns, and I could have had a good photo of him if I had taken my camera instead of the rifle. I whistled at him but he took no notice. It was not until I waved my arms and shouted that he decided to gallop off. I reached camp dead beat but happy, having seen a good deal of game.

Next morning I hunted the hillier country to the north-east. A fair number of bison were seen about two miles from camp, herds of

three or four cows and solitary young bulls. I heard elephant trumpeting and proceeded in the direction of the noise for two miles or so. I suddenly found myself in the middle of a herd of six of them. After watching them graze for some time—they were all cows—Maung Tan Bu gave a peculiar whistle and they lumbered off. I then descended into the bed of a ravine and was going along a game path through thickish stuff, when Maung Tan Bu, who was leading, turned about, thrust the ·470 into my hands and got behind me. Looking round the corner, I beheld the stern of a bison bull a yard away! He had the yellow horns of a youngster, so I was not going to shoot him, and he soon sensed that there was something queer about the place and dashed away with a snort. Shortly after this the jungle opened out and I spotted a solitary bison standing head down facing three-quarters away from me and thirty yards off. I went forward a few paces and saw that he was a very old bull, with a greasy, almost hairless hide, and blunt, dark-coloured massive horns. I gave him a raking shot in the ribs with the ·470, at which he lurched backwards, and I finished him off with the left barrel in the neck. He proved to be one of the best bison trophies I have so far obtained, with a spread of 36½ inches and a girth of 21 inches, well corrugated. The left horn had an extra growth extending for 5 inches across the forehead. I made tracks back to camp, which was reached at 10.30. Villagers were sent to bring in the head and meat, which arrived at tea-time.

I spent Sunday, the 27th, and Monday, the 28th, hunting for *saing*, but did not get in a shot. I saw one bull trotting away and a herd of cows and any amount of *gyi*. A heavy thunder and hail storm caught me on the way back on the Sunday.

Tuesday, the 29th, was a red-letter day. I left camp at dawn along the Wapyudaung cart road, and within a mile came upon the fresh tracks of a solitary bull *saing* crossing the road. I followed these in the direction of a herd of village buffaloes, whose bells we could hear. The tracks led into a patch of thick stuff and I heard the *saing* crash away just in front. I followed for about a quarter of a mile and the jungle became more open. I then spotted the *saing* standing broadside on, about 50 yards off, looking away from me. He had a dark chestnut hide and there was no doubt about his head being a good one, so kneeling down I knocked him over with the right barrel of the ·470 and finished him off with the left. He had a grand head, massive and well corrugated, with a span of 35 inches and a girth of 18½ inches, the tip of his left horn being worn away. One tracker was sent back to Onzon to collect villagers. When these arrived, I had the mask and head removed and reached camp before 8 a.m. I spent the morning fleshing and salting the mask, a back-breaking job.

After tea, I went again in the same direction and came upon the

fresh tracks of another solitary bull *saing*. These were followed for a short distance through a herd of grazing village buffaloes and lost. Maung Tan Bu picked them up again in the dry bed of a small stream and shortly after this I spotted the *saing* lying down 40 yards away. Steadying the ·470 against a tree I fired at his shoulder and he collapsed. He got up immediately, however, and it took two more shots to finish him off. He was a very old bull, his left horn being worn half-away and his right well rounded and splintered at the tip. The horns were not quite so massive as those of the morning, having a girth of 17¾ inches, but were deeply corrugated. I reached camp before dark.

I took an easy day on the 30th. The head of the evening's *saing* arrived at 9 a.m. and was duly cleaned. There was another thunderstorm in the evening.

I spent the whole of May 1st hunting for bison in the hills to the south-east. Not counting the ubiquitous *gyi*, I first saw a bull elephant on the move some distance in front. I followed his tracks until I drew level with him and saw that he had poor tusks. The only bison I came across were three cows. On the way back, I met a couple of pig, one of which I slew for the sake of its meat with the ·300. In previous *shikar* trips in India, I have found the bagging of a pig to be a good omen, and this was to prove no exception. Another thunderstorm during the night. I left camp at dawn on Friday, 2nd May, preceded by a party of villagers who had gone to collect the pig.

At 6.30 a.m. I saw a herd of elephant feeding in open jungle, about a hundred yards away. At the head of the herd was a fair-sized tusker. I walked up to a tree twelve paces from the tusker and gave him the right barrel of the ·470 midway between his left eye and ear-orifice. He was standing broadside on to me and on receiving the solid ·470 bullet he staggered against a rock to his right, presenting his stern to me. I fired the left barrel at the back of his left ear. This appeared to revive him and he trotted off to my right, Vellayan firing at him with my spare ·400. By the time I reloaded he had collapsed, 52 yards from his original position. The tusks were a decent average for Asiatic elephant, weighing 30 lb. apiece, with a length of 4 feet 9 inches and a girth of 14¾ inches.

I waited for the sun to rise sufficiently to enable me to take an indifferent photograph and reached camp at 8. The pig arrived during the evening and the tusks and forefeet at dusk. Practically the whole village went out to collect the meat, to be cut up into strips and dried. I had by now provided the villagers of Onzon with enough meat to last for months. Twice the circumference of the tusker's forefoot gave him a height of 9 feet 5 inches.

I spent the 3rd, from dawn till dusk, hunting for bison, without success. A good *sambhur* stag was seen lying down, but by the time

I had taken my rifle from Maung Tan Bu it had gone. I got to close quarters with a herd of elephant with calves and, making a detour, came upon a herd of *saing* cows. These stood and watched us for some time, and did not gallop away until I continued my progress. On topping a ridge, I surprised three young *sambhur* stags at their midday siesta just over the crest. Two of these immediately decamped, but the third, with horns about a foot long, stamped his forefoot and belled at us. He was only 15 yards away. I waved my white handkerchief at him, but he continued to bell and stamp. I then approached him, whereupon he decided that discretion was better than valour. After this episode a *serow* was put up and I caught a glimpse of him as he disappeared amongst the rocks and undergrowth. On the way back to camp we disturbed a herd of *saing* in bamboo jungle.

I paid off Maung Tan Bu and his compatriot. They each received one rupee per day as pay, and in addition I gave them ten rupees for each *saing*, bison and elephant, Rs. 40 in all to divide between each other. They were extremely satisfied with this scale of payment. I had also made it a habit, after bagging a decent animal, of giving them each a peg of whisky and a cigarette. The villagers who brought in my heads and tusks and cleaned them neither expected nor asked for payment. I suppose they considered themselves well paid by the meat I had provided. In this respect, they are very different from their brethren in India that I have come across.

Maung Tan Bu asked me for a "chit," and showed me one from Sir Godfrey Thomas, given him during the Prince of Wales' visit to Burma in 1921. I found the language difficulty not very great. My interpreter, Maung Ba Sein, acted only in camp and did not accompany me tracking. In the jungle we conversed sufficiently well for all practical purposes by means of signs. At this camp I also employed a villager as waterman at eight annas per day.

I struck camp early on the 4th and returned to Wapyudaung. Heavy rain detained me here for the day. I left my trophies with the rest-house *darwan* for safe custody, and next morning went to a village called Kyaukhlebin, six miles farther up the Mogok road. Here I lived in the P.W.D. rest-house, and engaged two Shans as trackers. I spent three days hunting for bison, extremely hard work climbing up and down the *khuds*. On two occasions I got to within a few paces of solitary bulls, but neither of them had a sufficiently good head and consequently they were not molested.

In the middle of one afternoon a panther was seen walking along the hillside fifty yards away. He had not seen us and was duly added to my bag. One morning, just outside the village, I saw a couple of wild dogs. I fired at one of these with the ·300. He turned a complete somersault and ran off. My Shans followed his blood trail for some distance, but did not find him.

1.—My Thamia.

2.—Saing shot on 29th morning.

3.—The camp at Lehla.

4.—Market on the river bank.

Shikar in upper Burma

On the evening of the 8th, I obtained a bus for 30 rupees and moved my belongings up to Mogok.

The road winds along mountain sides through delightful wild scenery. In Mogok I stayed at the circuit-house and spent the 9th paying calls, getting clothes washed, and arranging for Yunnanese muleteers to take my kit to Bernardmyo, which was said to be the best ground for *serow*.

It was raining heavily on Saturday, the 10th, and the muleteers, who had promised to be present at 6 a.m., did not turn up till midday. I left my tents and most of my stores at Mogok and loaded up a light kit on six pack mules. I left Mogok in rain at 12.45 p.m. and climbed the pass, about 6,000 feet, separating the Mogok and Bernardmyo valleys. It never ceased raining and the track was very slippery. I reached the forest rest-house, which was to be my abode for the next ten days or so about 4.30 p.m. It was a somewhat dilapidated wooden structure with a thatched roof that leaked like a sieve.

The Bernardmyo valley is very pretty, being a mixture of Westmorland, Kashmir and the Nilgiris. It is inhabited by Lishaws, Gurkhas and a few Burmese and Chinese. From the hilltops can be seen, to the west, the lovely range of the Shwe-u-daung, and, to the north, the Irrawaddy winding towards Katha and Bhamo.

The correct charge per pack mule from Mogok to Bernardmyo is one rupee. I gave slightly more than this because of the wet weather. As *shikaris* I engaged one Lishaw and one Gurkha. The Lishaw was a cheery, red-faced rascal, a born *shikari*, with a tendency to pocket my cartridges when he thought he was unobserved. He proved to be infinitely superior to the Gurkha in all respects. His name was Maung Kywe. It cleared up sufficiently on the morning of the 11th to enable me to hunt for *serow*. I followed tracks in a steep, thickly-wooded ravine, and the *shikaris* saw *serow* twice, but I did not.

The 12th opened fine and I hunted another deep ravine for *serow*, down one side and up the other, gruelling work, very reminiscent of stalking in Kashmir. I found numerous overhanging rocks where *serow* had obviously been lying up, and eventually the Gurkha spotted a *serow* standing under an overhanging wall of rock up above us and about 600 yards away. He lay down and I made my fellows do the same. Maung Kywe, carrying the ·300 and I, then began our stalk. We crawled across a bare side of the hill in full view of the *serow*, but he did not appear to notice us. We then got into dead ground and approached a ridge, well within range of the *serow's* resting-place. Looking cautiously over, I could see no trace of the *serow*. He had vanished. We made our way slowly up the ridge, and suddenly saw the *serow*, twenty yards above us, gazing into space. I seized the rifle from Maung Kywe and shot it through the chest. It had quite a good head, ten inches long and five and a half

inches in girth. My *shikaris* skinned it there and then, cut up the carcase and took the head and meat back to camp.

I spent the next two days hunting for *serow* and although I caught a fleeting vision of several, I did not get a shot. I bagged a couple of *gyi* in the evening.

The monsoon arrived in earnest on the 15th and I was unable to stir from the bungalow. The leaking roof made life somewhat unpleasant, as it was cold as well as wet. I decided to abandon *serow* hunting, return to Mogok and try for the second bison allowed on my licence in the lower ranges. Accordingly, I returned to Mogok early next morning in pouring rain. S——, the District Forest Officer, and his wife, very kindly gave me breakfast, and at 2 p.m., having put my kit and servants into a bus, I left for Shwenyaungbin, midway between Mogok and Thabeitkyin. At Shwenyaungbin I camped in the comfortable P.W.D. rest-house. Here I engaged a couple of Kachin trackers, and spent two and a half days bison hunting. I saw elephant, bison and *sambhur*, but no really good old bull bison, so I did no shooting. I found, however, the complete skeleton of a *serow*, with quite a good head.

On Monday evening, May 19th, I proceeded to Thabeitkyin by bus, picking up the heads left at Wapyudaung, and embarked on the s.s. *Kasna*, arriving at Mandalay at 3.30 p.m. the next day.

I paid off Maung Ba Sein, Vellayan returned to his military duties, and I rejoined my wife in Maymyo. Next day I went to bed with malaria. It appears impossible to hunt big game in Burma without catching this cursed fever. My three servants succumbed to it also. Fortunately it did not last long, and on June 2nd I left Maymyo on a hunt for *thamin*.

The district recommended by the Game Warden was 300 miles down river from Mandalay, and two marches inland from the river to the west. I spent two lazy, comfortable days on the s.s. *Minlat* and reached Minhla at 9.15 a.m. on the 5th. I had written to the Township Officer of this place to have two bullock carts ready for me, but they were not. I went to call upon the T.O., who gave me coffee, biscuits and fruit, was altogether charming, and promised that carts would be ready by noon. They were not.

The carts eventually rolled along at 4 p.m. and I got started. Taungu, the next village, was reached at 9.30 p.m. by moonlight, and after a scanty supper I went to sleep in the rest-house. Two more carts were produced early next morning, and Lehla, my destination, was reached at noon. Camp was pitched just outside the village. The villagers said *thamin* and *gyi* were plentiful, and I engaged two guides. I spent from the 7th to the 11th hunting for *thamin*. It was, however, rather late in the season. The jungle had become thick and game was very difficult to see. I succeeded in shooting one fairly decent *thamin* and saw a fair number of hinds.

Altogether I saw about ten stags, but they were seen trotting off in the undergrowth and gave no chances. A month earlier the forests would have been more open and game easier to see. In addition to *thamin*, I saw a large, solitary, tuskless elephant, numerous *gyi*, tracks of tiger and panther and an abundance of hares and partridges.

This district, I understand, is one of the few accessible ones now holding *thamin* with shootable heads. There are no *shikaris* available, as I understand the term, but for *thamin* shooting, one requires only a guide to show one where game is likely to be found and lead one back to camp again.

I ordered carts to be ready at dawn on the 12th and reached Minhla that evening. Embarking on the s.s. *Kalaw*, next morning, I reached Mandalay on the evening of the 15th and motored straight up to Maymyo. Here I was confined to bed for a week with a second attack of malaria.

Whilst in camp with my Field Company at Wetwun, near Maymyo, during the first ten days of November, I heard that *serow* were obtainable in the ravines about four miles away.

I accordingly arranged one day to have a beat.

A dozen Shan beaters were considered necessary by the local *shikari* and the *hukm* duly went forth. The first four beats were blank, but the fifth produced a good *serow* of over nine inches.

From the foregoing it will be seen that excellent sport can be obtained in Burma at the present time by those who care to look for it. The *bandobast* is neither difficult nor expensive. The Government of Burma have published an excellent *Burma Game Manual*, which is full of information. Any further information required and advice can readily be obtained from the Game Warden and District Forest Officers.

I found that the most expensive item of my trips was the cost of travelling on the river, but a voyage by one of the Irrawaddy Flotilla Company's steamers is an extremely interesting and enjoyable experience.

THE BRIDGING OF THE BERESINA, NOVEMBER, 1812.

AN EXAMPLE OF IMPROVISATION.

By LIEUT.-COLONEL L. CHENEVIX-TRENCH, C.M.G., D.S.O., R.E.

ON the 24th June, 1812, Napoleon's Grand Army crossed the river Niemen and began the invasion of Russia. During the preceding night three bridges, each over 200 yards long, had been built; a fourth was added next day. The great river was no obstacle to the well-trained, fully-equipped pontoneers who thus prepared the way of the greatest army the world had yet seen.

On the 14th September, 83 days after starting, Moscow was entered. A month of fruitless negotiations followed and then, on the 19th October, the great retreat began. Detachments, battle casualties and the wear and tear of the 600-mile march from the frontier had reduced the Army to a fraction, probably not more than 30 per cent. of the 400,000 who had entered Russia. By the time Orcza, barely half-way home, was reached, there remained only about 30,000 men in formed bodies and rather more than that number of stragglers.

Here it was that Napoleon determined to cut down his baggage columns, and, with the horses thus made available, to make up his gun teams; here he destroyed his eagles; and here he abandoned his bridging train, destroying the 60 precious boats which it carried.

The situation was certainly one to lead him to set more value on guns than on pontoons. Behind him followed Kutusov, at a respectful distance it is true, but with an army stronger than all his skeleton corps could muster. To his left rear Victor's IX. Corps with about 10,000 effectives, was with difficulty holding off three times that number of Russians under Wittgenstein. In the south the Austrian, Schwartzenburg, faced, or should have faced, the Russian Admiral Tschitschagov. Here numbers were not quite so much against Napoleon, but the quality of the troops, and above all of their General, was not equal to that of the rest of the French Army. Napoleon's orders to Schwartzenburg had been plain enough; at all times he was to keep his army interposed between the Admiral and the bridge over the River Beresina at Borissov. This river, 80 miles to the west of Orcza, was the last serious natural obstacle between Napoleon and safety. If only Schwartzenburg obeyed his orders the crossing ought to be safe enough and there would be no use for the bridging train; but there would always be a use for guns.

So, on November 20th, the bridging train was burned. While it was burning the Admiral was dodging past Schwartzenburg, who had neglected his orders, and making for Borissov with 40,000 men. On the 21st this vital point, after some hard fighting with Dombrovski's Polish Division, fell into the Russian's hands. Two days later he was, it is true, driven out by Napoleon's advanced guard, and with heavy losses, but in falling back over the bridge he succeeded in destroying it so effectually that its repair in the face of the enemy was impracticable, since it was nearly 600 yards long and broken in three places. It is hard to imagine a worse position than that in which Napoleon found himself when, on the 23rd, news of the destruction of the Borissov bridge reached him. His only line of retreat was barred by an unbridged * river, on the far bank of which 35,000 Russians awaited him; two more armies, each as strong as or stronger than his own, were closing in on him from flank and rear. Even if his troops had been in the best possible shape, the situation would have been desperate enough, but their condition was nearly as bad as it could be. Starving, frozen and demoralized, weak with typhus and covered with rags half-burned from huddling too close round the bivouac fires, none would have recognized in them the Grand Army of five months before.

Yet he escaped and with him the majority, at any rate, of his fighting troops. It is true that the stragglers, the sick and wounded, and all who were not in formed bodies were lost, but these in any case could hardly have survived the march for many more days.

The manner of his escape was as follows;

Away back in Smolensk, 160 miles to the east, General Count Eblé, who commanded the bridging trains of the Army, had insisted on every man of his pontoneers carrying 15 or 20 long nails, one or two iron dogs or a tool of some sort. In addition he had managed to save six limbered wagons containing carpenters' and smiths' tools, with more nails, spikes and dogs, two cartloads of tyres from the wheels of broken-down wagons, two field forges and two wagonloads of coal. The foresight, determination and discipline required to preserve such things through hundreds of miles of marching, justify the verdict of Ségur that this artilleryman,† Count Eblé, saved the Army.

* The bridges carrying the Vilna-Witebsk road across the river near Weselowo, a few miles farther north, had been previously destroyed by the Russians and in any case were little more than footbridges.

† The pontoneers were under the artillery and were distinct from the sappers, though on this and other occasions they worked together. Count Eblé was a gunner and was, in fact, appointed Inspector-General of Artillery a few weeks later. Unfortunately he died of the sufferings he underwent on the Beresina, before he could take up the appointment. The personnel at Eblé's disposal consisted of seven companies of pontoneers, in all some 400 men, of whom each still retained his musket. This in itself was a proof of more than ordinary discipline. Besides these there were some companies of sappers, and the remains of the "Battalion of the Danube," a corps of watermen, all under General Chasseloup, the Chief Engineer.

Eblé and General Chasseloup (Chief Engineer) arrived in Borissov at 5.0 a.m. on the 25th.

Meanwhile Oudinot, whose corps it was which had re-captured Borissov and driven the Russians back across the bridge to the right (western) bank of the river, had been searching for a crossing-place. He located one ford a few miles below the town and another just above it, but the first was deep and uncertain, while the other had bad approaches. One of his brigadiers then, quite by chance, found a third near the village of Studzianka, 10 to 12 miles up-stream from Borissov. This one appeared passable,* and was, moreover, near the most direct and least dangerous route to Vilna, whither, as Oudinot knew, Napoleon intended to move. He therefore at once, on the night of the 23rd, sent a strong detachment to occupy Studzianka. Reconnaisance had shown that the Russians already expected the French to turn south, for they had strong forces guarding the western exits of the two down-stream fords. In order to strengthen them in this belief a detachment of some 300 men, together with some sappers and a crowd of stragglers, was moved on the 24th to the southern ford, with orders to begin preparations for bridging and to carry them on in full view of the enemy. In addition a cuirassier division was ostentatiously marched in the same direction. As a further step to mystify and mislead Admiral Tschitschagov a number of the local Jews were brought in, and closely questioned regarding the down-stream ford and the way from it to the Minsk Road. "Then," says Ségur, "after pretending to be very pleased with their answers, the French Staff caused these traitors to be led through the outposts and released, confident that they would betray what they believed to be the intentions of Napoleon. In order, however, to make doubly sure that they would break faith, an oath was extracted from them that they would return to the Lower Beresina with information about the Russians."

Eblé and Chasseloup arrived at Studzianka with the pontoneers and the remainder of the sappers at 5.0 p.m. on the 25th and held a conference with Oudinot and Murat, at which it was decided that three bridges should be made, two by the pontoneers and one by the sappers. There had been a thaw for the last two or three days, which had caused the water to rise and destroyed any prospect there may have been of crossing by fording.

Part of Oudinot's Corps had, as we have seen, moved to Studzianka on the night of the 23rd and had, therefore, by now been there for two days. During this time they had made some 20 trestles. Napoleon, counting on being able to use these, had ordered the bridge to be made ready by 10.0 p.m. that night. Unfortunately they turned out to be much too weak and were useless for any purpose, so all had

* There is some doubt as to whether this ford was really usable except in very dry weather. In any case, as will be seen later, it had to be bridged.

to be begun over again, and Napoleon told that the bridge would not be ready. He ordered work to be pushed with all speed and so, throughout the night, pontoneers and sappers toiled at collecting material and making stronger trestles. The forges were got going and a stock of dogs and spikes made from the iron tyres salved from abandoned wagon wheels. As there were no boats of any kind, three small rafts were made, each capable of carrying ten men.

At dawn on the 26th, Eblé was able to make his first daylight reconnaissance of the river and found that it was 108 yards wide, not 80 as he had been told on the previous evening. This discrepancy, due to the rising of the water, necessitated reducing the three bridges to two, and Chasseloup's was accordingly abandoned. Some time previously, probably on the day before, a Russian division of some 6,000 men, under General Tschaplitz, had taken up a position on the opposite bank and Ségur declares that the trestles were actually made by the light of Russian bivouac fires. Though this may be rather an exaggeration yet in any case the work must have been in full view, as soon as daylight came, especially as the western bank was rather higher than the eastern. The troops who were to use the bridges were, however, kept out of sight and the crowds of stragglers had not yet come up. Tschaplitz fired a few rounds of artillery, but made no further attempt to interfere, and then, to everyone's amazement, started to march off south. Apparently Napoleon's attempts to deceive the Admiral had succeeded and Tschaplitz, with or without his own consent, was withdrawn from the critical point at the critical moment. All that was left was a rearguard with few guns, and the ubiquitous Cossacks. These were kept at a distance by the French artillery which, however, had to be sparingly used lest the sound of a cannonade might bring Tschaplitz back again. Soon a squadron of chasseurs swam across through the mud and ice, and were followed by the rafts which in repeated journeys ferried some 400 more men over. These gained a sufficiently wide bridgehead for the launching of trestles to begin, and by 1 p.m. the northern bridge was finished. This bridge, designed to take infantry and cavalry only, was first of all crossed by Oudinot's Corps, which immediately after doing so turned left and took up a position facing south near Stachow.

By exercising great care an eight-pounder and a howitzer together with their limbers and a few S.A.A. wagons were also got over, but the bulk of his guns and wheels had to await the completion of the second bridge, which was sited 200 yards below the first, and it was not till 4.0 p.m. that it was ready. The artillery of the II. Corps immediately crossed and turned south to join its infantry. Other batteries followed, but, in spite of all orders against trotting, insisted on doing so. The rough corduroy decking, which was all that could be provided, would not stand this, and at 8.0 p.m. three trestles collapsed. The exhaustion of the pontoneers and sappers, who after

over 24 hours of continuous work under terrible conditions, had thrown themselves down to sleep, made repair of the broken bridge a task of the utmost difficulty. However, by 11 p.m. it was done and the stream of traffic flowed on. At 2 a.m. on the 27th, three more trestles collapsed, owing to their legs sinking unequally into the muddy bottom. This time it was in the deepest part of the river and not till 6 a.m. could the passage be resumed. Napoleon's patience was getting exhausted and Eblé, who with his men must have been on the go since dawn on the 25th, felt the whip; but neither he nor they could do more than they were doing. Few could have done so much. Since the 25th the weather had turned again to cold, accompanied by a gale of wind, and though this froze the marshes on each side of the river and so rendered the approaches passable by wheels, it caused intense suffering to the men, of whom many had to work breast deep in the icy water. Several were swept away in doing so and others collapsed on regaining the shore.

All through the 27th the crossing continued, till at 4 p.m. there was another break in the artillery bridge, which it took two hours to make good. The northern bridge, though it did not actually collapse, was getting very shaky. The decking was broken in many places and had to be covered with grass and brushwood, to prevent horses' feet from going through it. Those units which still kept formation marched three abreast and well spaced out.

With nightfall the stragglers, who had hitherto only appeared in small numbers, began to arrive in crowds, together with a heterogeneous mass of transport. The confusion during the night was terrible as the desperate, hunger-driven creatures fought their way to the bridges.

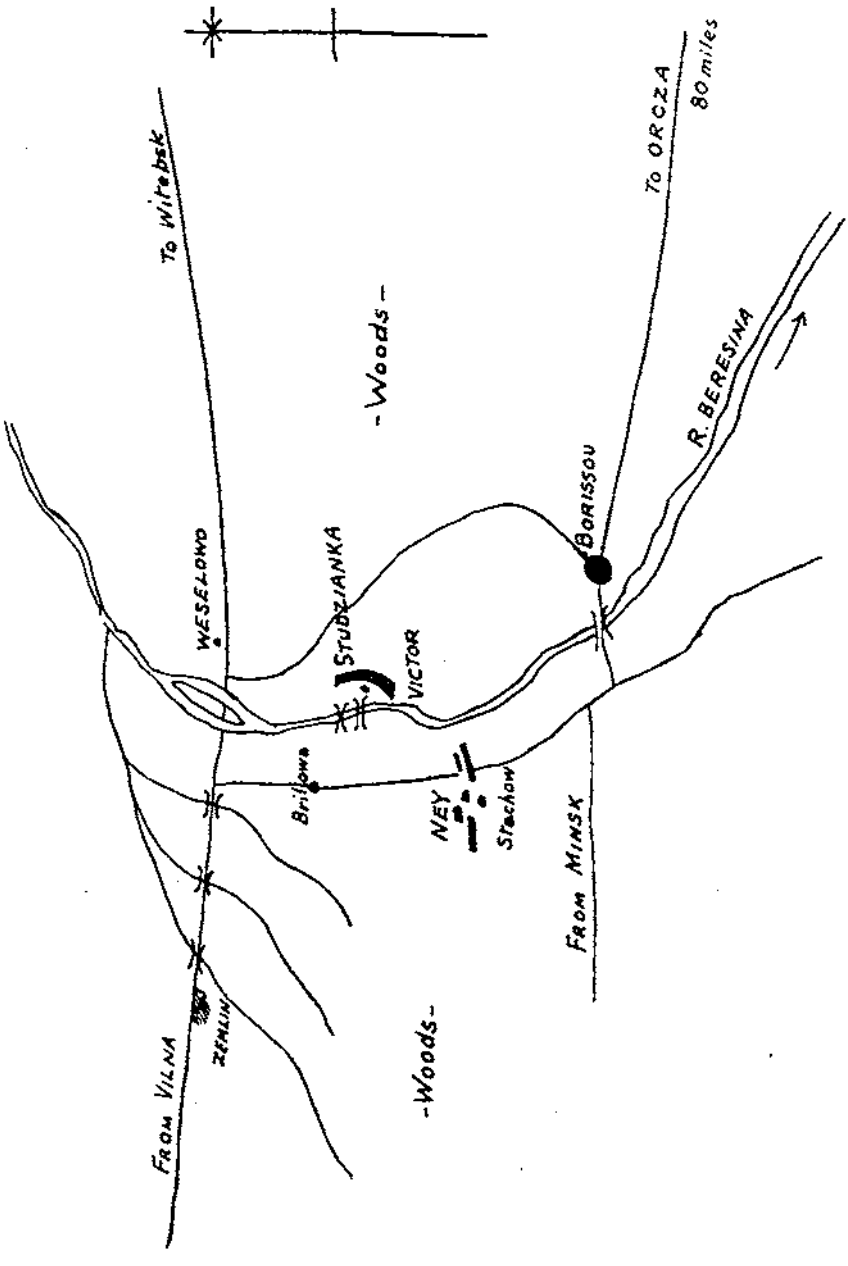
On the 28th things were even worse, for the Russians under Wittgenstein were attacking the rearguard and had got their artillery to within range of the bridges.

A solid mass of transport, men, and animals, with here and there a little clot of armed men whom discipline or self-interest banded together, choked the approaches to the bridges over a width of 1,200 yards and for a depth of 300. Into this great target the Russian guns plunged their shot till darkness spoiled their aim.

Many were killed by the artillery but more were trampled to death or drowned among the ice floes as they slowly swept downstream. At nightfall firing ceased on both sides and the problem of getting the rearguard over the river had to be faced.

This rearguard was composed of the IX. Corps under Victor. Many of his troops were Germans and Poles, but they fought as bravely and as loyally as any Frenchman. The corps had suffered the loss of one of its divisions, left in Borissov by Napoleon's orders and cut off while trying to rejoin. Thus weakened, the corps could not cover the whole frontage necessary to protect the bridges and its

THE BERESINA SITUATION ON 28th NOVEMBER, 1812.



left (northern) flank was turned by Wittgenstein during the 28th. A series of gallant cavalry attacks restored the situation, though the two regiments which made them were almost completely destroyed.

Eblé had reported to Napoleon that it would take at least six days for everyone to cross the river, but it was clear that the IX. Corps could not maintain its position any longer and orders were issued for it to start withdrawing at 9 p.m. Eblé and his men were once more in demand. A way had to be made through the half-dead, half-living mass which choked the bridges and the near bank. With 160 of his pontoneers he cut and cleared a road, though the work was almost too much for their weary limbs. At last the horrible task was done and Victor's men began to cross. By 1 a.m. on the 29th they were all over, except for the demolition parties, and the bridges were empty. There still, however, remained on the eastern bank great numbers of sick and wounded, stragglers, women and children, transport men and armed but exhausted soldiers. Now was the time for them to cross and both Victor and Eblé personally exerted themselves to the utmost to make them do so. They were, however, so stupefied by the cold and exhausted by their exertions of the past few days, that even the warning that the bridges would be burned the next morning, failed to rouse them. Eblé then himself set fire to a pile of wagons, hoping that the sight of the flames would frighten those who could yet move, out of their stupor ; but it was in vain, and throughout the night only a few took their last remaining chance to escape.

Napoleon had given orders for the bridges to be set on fire at 7 a.m. on the 29th and all was got ready for this to be done. Eblé, however, could not harden his heart to abandon his countrymen without another effort, and till half-past nine, with the remainder of his devoted pontoneers, went round the miserable bivouacs trying to stir their occupants to cross before it was too late. At last he could wait no longer ; the Russians were beginning to move and he had to go. At 9.30 a.m. he ordered the torches to be applied and set off in the wake of the retreating Army.

For some time the Russians hesitated before advancing on their prey and contented themselves with pounding it with their artillery. Then, convinced at last that there was no fight left in the mass which heaved and surged beneath them, the Cossacks closed in.

Meanwhile during all the 28th there had been heavy fighting on the western bank of the river, to hold back Tschitschagov who, appreciating at last how he had been deceived, had turned north with all his strength to attack anything he might find on the right bank. Unfortunately for the Admiral he found Ney, with Oudinot's Corps and the Young Guard. These, though outnumbered by three or four to one, held him off about the village of Stachow and after hard fighting defeated him with great slaughter and the loss of 4,000 prisoners.

Beyond the Beresina the road led westwards via Zembin, but before

this place could be reached there were three long trestle bridges, or rather, causeways, leading over streams and swamps, to be crossed. Luckily for the French, the Russians had omitted to destroy these bridges, though they might easily have done so, and thus certainly have captured the whole Army. They were in all about 600 yards long and had piles of brushwood already prepared under them for setting on fire. The French made no mistake. As soon as the last troops had crossed and the pursuing Cossacks approached, Eblé performed his last service and handed the duty of the rearguard over to the flames.

Though the Beresina was crossed, yet the Grand Army had practically ceased to exist. Probably not more than 20,000 men remained in anything like formed bodies and even these were almost entirely broken up before the frontier was reached.

Yet Napoleon escaped and on the 3rd December left for France, reaching Paris in 14 days; far enough ahead of the bad news to consolidate his position before it could arrive. A Leipzig and a Waterloo had yet to be fought.

NOTES.

1. The banks of the river were marshy, particularly on the right, and if it had not been for the hard frost, no vehicles would have been able to get on or off the bridges. The bottom was muddy and uneven, and sheets of ice were swept down by the rather sluggish stream. Each bridge required 23 trestles. Some with two, some with four, and a few with six legs; they were from three to nine feet high, with 14-foot transoms. Bays were from 13 to 14 feet long. Material was found from the huts which formed the village of Studzianka and from the neighbouring woods. Road bearers were from five to six inches thick; on the southern bridge the roadway was of logs three to four inches in diameter; on the other—the infantry bridge—planks from the village were used, laid three deep as they were only about $\frac{1}{2}$ inch thick.

2. Although a large proportion, probably nearly half, of the Grand Army was not French, there was never any resentment against Napoleon for the fate to which he led his troops. Many committed suicide, but none ever raised hand or voice against the Emperor. To the very last his influence was supreme and unquestioned.

3. The hardships of the Russians were nearly as great as those of the French and their losses were very heavy. Throughout the retreat they were reluctant to close, and whenever they did so were roughly handled. Any unarmed stragglers who fell out from the main body

were soon dealt with by Platow's Cossacks, but even quite small bodies of armed men were seldom interfered with. As for Napoleon himself, each of the three Russian Army Commanders was most anxious that the others should attack him, but as a rule took good care not to do so himself. Russian accounts much overestimate the strength of the French, but this may have arisen through counting the crowds of stragglers as fighting troops.

4. Few of those taken prisoner by the Russians ever came back again. Either cold and hunger, or the clubs and knives of the women soon finished them off.

5. Eblé did not long survive the hardships of the crossing but died at Königsberg on the 30th December. Most of his men failed to get even so far; 30 per cent. of them died on the Beresina.

6. It is interesting to note how slender were the material resources with which the Army was saved. Not more than 10 wagonloads in all, and they must have been light to have got as far as they did.

7. The rather sudden increase in the width of the river nearly brought failure. Such a change is by no means uncommon, whether caused by enemy action or by the weather.

8. The failure of the Russians to destroy the causeways west of the Beresina, although they prepared them for demolition, was an omission of which many campaigns can provide instances. One rarely reads, however, of a bridge being destroyed too soon, or unnecessarily.

9. Tschitschagov's belief that Napoleon was going to cross south of Borissov, was turned to conviction by Napoleon's ruses. In spite of his efforts after the crossing had been effected, he was disgraced for allowing Napoleon himself to escape.

10. The vital necessity of retaining, during bridging operations, some reserve, both of personnel and of material, is clearly shown by the long delays which occurred whenever the bridge broke down.

THE MIX-IN-PLACE METHOD OF ROAD CONSTRUCTION.

By CAPTAIN W. L. CAMPBELL, M.C.

As the name implies, mix-in-place is a method of construction whereby a bituminous binder is mixed with the aggregate "in place," *i.e.*, the actual road surface is the site of the mixing process. It is a method which has developed from the use of grading machinery for the construction and maintenance of earth and similar type roads, and just as road-grading machinery originated in America, so it is in America that mix-in-place was originated and developed.

The idea underlying mix-in-place is very well described in the following extracts from the *Bitumen and Tar Road Construction Report*, submitted by the American Engineers to the 6th International Road Congress, held at Washington in 1930:—

> "The extraordinarily easy-riding quality of a well constructed and properly maintained gravel road has been widely noted and commented upon by engineers as well as by the travelling public. Most of these gravel roads are at their best when the gravel is moist but not saturated with water. If they could be kept permanently in this condition, their traffic-carrying capacity would be much higher and the cost of maintenance would be greatly reduced. . . . Although perhaps not generally recognized, the basic principle of the use of bituminous material in what has been termed the 'surface-mixed' or 'mixed-in-place' gravel road appears to be the substitution of bituminous material for that amount of water which would produce the most satisfactory condition for the particular untreated aggregate."

The method can best be appreciated by reference to the photographs accompanying this article, but it might be advisable first of all to give a brief summary of the process.

The existing road surface is scarified to the required uniform depth, which may be anything between 2 and 4 inches, and the scarified aggregate is then harrowed and afterwards respread uniformly, by the grader, over the width of road being treated. From traffic considerations, half-width construction is generally adopted. This process of scarifying, harrowing and respreading results in the complete breaking down of all caked material—an essential condition for mix-in-place, in order that each and every fragment and particle of the aggregate may be given its subsequent coating of bituminous

binder. (Another essential condition is that moisture content of aggregate should not exceed 2 per cent.) The aggregate is then sprayed with the binder, this being an asphaltic oil, applied hot, the usual rate of application being from 1 to 1½ gallons per square yard, depending on the aggregate and depth of mix. In order to obtain in the first instance the best possible incorporation of the road oil with the aggregate, the oil is generally applied in instalments not greater than ½ gallon per square yard, and after each instalment the aggregate is either harrowed, or turned over by the grader, so as to expose uncoated aggregate to the next application of the oil. Immediately the final instalment of oil has been applied, the mixing process proper commences, and it merely consists in blading the oil-treated aggregate by means of the grader into the form of a windrow, and then working this windrow, again by the grader, to and fro between the edge and the centre of the road. In other words, the windrow is rolled over and over, until it is of uniform colour, and it is this rolling action which effects the mixing of the aggregate and the oil binder. When mixing is complete, the windrow is spread into place by the grader, and consolidation is effected by traffic. In the initial stages of consolidation, the mix-in-place surface is disturbed by the action of traffic, particularly by steel-tyred vehicles, and it is necessary to use a patrol grader or a drag to keep the surface in shape until it sets up. This setting-up period may be anything from a few hours to a week or so, depending upon the grade of oil used, atmospheric conditions and intensity of traffic. The more motor (*i.e.*, rubber-tyred) traffic using the road, the quicker will be the setting up of the surface and the formation of the so-called traffic crust, for motor traffic has the effect of consolidating the mix without seriously displacing it, whereas steel-tyred traffic tends to cut into and displace the surface during the setting-up period.

After consolidation and formation of the traffic crust, the surface has the usual asphalt appearance. Moreover, by reason of the machine finish, *i.e.*, the smoothing action of grading machines or drags, the surface is just as true as any obtained in the more expensive forms of construction.

Attention can now be turned to Photographs Nos. 1 to 11. These were taken on a 12-mile contract job, carried out in 1930 on the Redwood Highway, in the neighbourhood of Klamath, N.W. California. This is a comparatively small-size mix-in-place job, so far as America is concerned, for although no actual figures are available, there are many thousands of miles of mix-in-place work in the Western States, and a 50-mile or even longer individual mix-in-place job is not uncommon. On this Klamath job, the contractors had their full-scale equipment, consisting of a 2,000-gallon oil distributor, fed by tank lorries from the railhead, 4 grading machines, each drawn by a 30-h.p. caterpillar tractor, and a disc harrow drawn by a 20-h.p.

tractor. The work was carried out in half-widths of the roadway, each day's work consisting of a 4,000-foot length, 10 feet wide. That is, in two days, a 4,000-foot run of road, 20 feet wide, was completed. On this particular job, the aggregate for the mix-in-place carpet was brought on to the road from a nearby gravel pit, and this question of the use of scarified material or of fresh aggregate will be discussed later. It is mentioned now merely in order to make the photographs clear, as they show the existing surface (traffic-bound gravel with asphaltic surface treatment) left untouched to form the base for the mix-in-place carpet.

Photograph 1 shows the first application of road oil to the half-width of aggregate, 4-inch loose depth. A total of 1½ gallons of oil per square yard was applied, in three equal instalments, temperature of oil on application being 150°/200°F. Behind the distributor will be seen the various units of the mixing machinery, viz., disc harrow and three graders. These are shown in detail in the next four photographs.

Photograph 2 shows the second application of road oil, and also the action of the disc harrow in getting the oil distributed into the body of the aggregate.

Photograph 3 shows the first grading machine, following immediately behind the harrow, and blading the "flat spread" of the aggregate into a windrow.

Photograph 4 shows the second grading machine, following immediately behind the first, and rolling the windrow towards centre of road.

Photograph 5 shows the third grading machine, following immediately behind the second, and spreading the windrow flat in readiness for the third and final application of oil.

After the final application of oil, the three grading machines, working one behind the other in echelon, continued the processing, *i.e.*, the rolling of the windrow from side to centre of road, centre to side, and so on, until a uniform mixture was obtained. On this job the final application of oil for the day was effected usually by 11 a.m., and mixing was completed by 4 p.m. or 5 p.m. The speed of the machines when mixing was about 1¼ miles per hour, and allowing for the time taken in turning at the end of each 4,000-foot run and for the hour's break at midday, the 5 hours' mixing period was practically equivalent to 5 one-way trips of the mixing "train" of 3 graders. That is, the windrow was turned over about 15 times after final application of oil. The required number of turnovers varies, of course, according to grade of oil, nature and size of aggregate, depth of mix, and atmospheric conditions, but fifteen is probably a very fair average figure. It is perhaps opportune to mention here that mix-in-place can be done with two grading machines, or with only one. For instance, if one grader had been employed on this

particular job, it would have had to make 15 one-way trips in order to get the same number of turnovers of the windrow as the 3 machines making 5 one-way trips. On the 4,000-foot length of run, these 15 trips would have occupied two days, and this extended period of mixing would introduce mixing difficulties owing to the road oil beginning to set up. Therefore, with one grader, the length of run would have to be reduced, and a ¼-mile section would probably be quite sufficient. It is advisable in mix-in-place work to make the day's run as long as possible, in order to avoid too frequent turning of the graders, and the loss of time that is thereby involved.

Photograph 6 shows mixing in progress after the final application of oil, and Photograph 7 shows mixing almost completed. On the extreme left of this photograph the aggregate for the other half-width of the road can be seen in the form of windrow, ready for mixing on the following day. The mixing of this windrow on that following day would be completed by about 4 p.m., and the final operation of that day would be to combine the two windrows. This operation is shown in Photograph 8, in which the left windrow had been mixed the previous day and mixing of the right windrow has just been completed. It is now being bladed flat, alongside the left windrow, and the latter windrow is then bladed flat, on top of the former. The " flat spread " of the two windrows so obtained is then split in two by the graders, and the two windrows so obtained are then each turned over once or twice, and finally combined in the form of one windrow down the centre of the road. The object of this operation, commencing with the combining of the original left and right windrows, is to ensure a uniform mixture over the whole width of road.

The following morning, whilst the three grading machines for mixing have commenced work on the next section, a fourth machine is employed on spreading the windrow of oil-mixed aggregate, as left from the previous evening. For this spreading operation, broad-blading is employed. That is, the blade of the grader is almost at right angles to direction of travel, in distinction to the 45° or 55° angle of the blade to direction of travel when mixing. Photograph 9 shows this broad-blading in progress on the left side of the road, the right side having been spread to required width.

Photograph 10 shows the drag employed for keeping the surface smooth during the setting-up period, and Photograph 11 shows construction completed except for the shoulders to the mix-in-place surface. These were built up later of untreated gravel.

Most of the early mix-in-place work carried out in America was done with gravel aggregates scarified from traffic-bound gravel surfaces. This type of surfacing material is not, of course, clean gravel, but material taken from local gravel pits, consisting of gravel, sand and clay. There are certain difficulties in carrying out mix-in-place

work with scarified aggregate of this nature, the chief ones being the difficulty of regulating the depth of the scarifying, and the difficulty of obtaining a smooth compact base for the mix-in-place carpet. In many cases, therefore, work is now done with fresh gravel aggregate, as in the case of the Klamath job just described, but, of course, this has the effect of putting up very considerably the cost of the work, unless suitable supplies of gravel are available more or less alongside the job. The position really is that the use of fresh aggregate is a refinement that can be indulged in if funds are available; otherwise, a perfectly satisfactory job can be made from scarified aggregate provided necessary precautions are taken. Of course, in talking of the use of scarified aggregate, it is always assumed that there is a sufficient depth of aggregate on the road to permit of the top two or three inches being scarified without weakening the road structure.

A typical grading for gravel aggregate as used in the Western States for mix-in-place is as follows:—

Passing	1″ screen	..	100%	of total aggregate.	
,,	¼″ ,,	..	50 to 65%	,, ,,	,,
,,	10 mesh	..	35 to 45%	,, ,,	,,
,,	200 ,,	..	6 to 12%	,, ,,	,,

With regard to the required road oil content of the mix, this is really settled by the appearance of the mix during construction, but there are a number of methods or formulæ by which a fairly accurate indication can be obtained prior to the commencement of construction work. For instance, the Californian "rule of thumb" formula is as follows:—

$$P = \cdot 02A + \cdot 045B + \cdot 18C$$

where P = required percentage by weight of oil in the mix.
A = percentage by weight of aggregate passing 1″ screen and retained 10 mesh.
B = ,, ,, ,, ,, aggregate passing 10 mesh and retained 200 mesh.
C = ,, ,, ,, ,, aggregate passing 200 mesh.

With an aggregate containing, say, 50% between 1″ and 10 mesh, 40% between 10 mesh and 200 mesh, and 10% passing 200 mesh, the required oil content, according to above formula, is 4·6% by weight. Assuming the aggregate weighs 2,700 lb. per cubic yard, in a loose state, and that a 4-in. loose depth of mix-in-place is being constructed, the theoretical quantity of oil per square yard is 13·8 lb., or, say, 1⅔ gallons, taking specific gravity of the oil as 1·00.

As a typical example of the cost of mix-in-place work, using scarified aggregate, the following figures are quoted, relating to a

56-mile job carried out by the State of Idaho in 1928. The width of surface was 18 feet, depth of mix between 2 and 3 inches, and the quantity of road oil averaged about 1⅛ U.S. gallons (say 1 Imperial gallon) per square yard.

Item.	*Cost per mile. Dollars.*	*Item Cost. % of total.*
Preparation and scarifying ..	121.00	8
Heating and spreading oil ..	127.76	9
Mixing and laying	266.12	18
Road oil	782.65	53
Supervision, overheads, daily rental charge of plant, etc. ..	175.96	12
	1473.49	100%

The cost per mile was thus about £300, but in considering this cost the very cheap price of road oil in the Western States must be borne in mind. On this job the road oil cost 6 cents per gallon, delivered in bulk, but for other countries where road oil has to be imported, its price may be anything from twice to four times the above cost. Taking, for instance, a price for the oil of 9d. per gallon, and assuming that the other item costs, as per above table, still hold good—as would more or less be the case—the cost per mile of work of a similar nature can be roughly estimated at about £600 per mile, of which the cost of the oil would represent about 75%. £600 per mile, for an 18-foot width, is equivalent to about 13½d. per square yard.

The value of mix-in-place in countries like Australia, India, Africa, etc., can now be appreciated. In these countries there are thousands of miles of gravel, laterite, moorum and similar type roads which under increasing motor traffic, and apart from difficult weather conditions, are very difficult and expensive to maintain. The cost of improvement in waterbound macadam, surface treated, or in any of the forms of bituminous grouting, would be anything from 2s. 6d. to 5s. per square yard. This is where mix-in-place steps into the gap, and provides a first-class asphalt surface, amply strong enough for the usual intensity of traffic on these roads, at a cost within the realm of financial possibility.

With regard to the life of mix-in-place surfaces, no definite figure can be given, for the reason that this type of work has been carried out in America only within the last five or six years, on any large scale, and all that can be said at the moment is that surfaces constructed four, five or six years ago are still in perfectly good condition and give every appearance of having a further life of at least several years. With regard to traffic-carrying ability, mix-in-place in the States is employed mainly on rural roads of moderate traffic, 300 to 800 vehicles per day, but even after five years' experience of this

method, a definite opinion has not yet been formed as to the maximum economic traffic-carrying ability of a mix-in-place surface, and in many cases traffic in excess of 1,500 vehicles per day is being successfully carried.

As regards maintenance costs, the State of New Mexico has just published some figures relating to their 500 miles of mix-in-place roads. The average annual maintenance cost is less than £50 per mile, but in considering this figure it should be stated that some of these roads are carrying at times 3,000 vehicles per day.

One interesting point with regard to maintenance is that with certain grades of road oil the mix-in-place carpet is still in a reworkable condition even after five years' service or longer. This means that if the mix is beginning to appear dry, it can be scarified, a further small quantity of oil added, remixing carried out, and the surface thus given a further long lease of life. Similarly, if during construction an excess quantity of oil had been used, with the result that after two or three years the surface has waved or " shoved " to any appreciable extent, all that is necessary is to scarify, add further aggregate and remix. This ability of mix-in-place to be " reworked " is somewhat unique, and it means that, whatever happens, the original investment in the mix-in-place surface is never lost.

So far, this discussion of mix-in-place has centred on the use of a gravel/sand type of aggregate. Excellent results from mix-in-place can also be obtained with soil or earth aggregates of almost any type, always provided that these are capable of being more or less completely pulverized prior to the mixing process. In most cases, the operation of scarifying the existing surface of the earth road, together with harrowing of the loosened material, will break down the earth to a degree of fineness suitable for mix-in-place. The use of a slight initial excess of road oil in the mix will take care of any small pellets of caked earth that may be present, for if these subsequently break down under traffic, there will then be sufficient oil present to envelop and bind the individual particles resulting from the breaking down of the pellets. Photograph 12 shows an earth road scarified in preparation for subsequent mix-in-place work, but before application of the oil, considerable harrowing was necessary in order to break down the clods of earth clearly seen in the photograph. The latter also shows the oil distributor used on this work, consisting of a 1,500-gallon trailer tank, replenished during distribution from the similar sized tank on the lorry. This photograph was taken on a job in Stanislaus County, California. Six days after completion, the whole surface had been brought to proper shape by the action of traffic and drag maintenance.

According to traffic and soil conditions, the depth of mix-in-place work usually carried out on earth roads is anything from 3 to 6 inches, and the quantity of road oil required varies from about

1½ to 4 gallons per square yard, depending on depth of mix and fineness of soil.

Mix-in-place also offers great possibilities for improved roads in desert areas. In areas of this nature in the States, large mileages of sand mix-in-place work have already been carried out, but in this connection, instead of quoting an American example, it will probably be of interest to give details of the first mix-in-place work carried out in Eygpt. This work was a demonstration length, located on the Pyramids–Fayoum road, 5 kilometres beyond the Great Pyramid, and was carried out in April, 1931. The aggregate was desert sand, of the following average grading :—

Retained 10 mesh	14%
Passing 10, retained 200	81%
Passing 200 mesh	5%

A 3-inch consolidated depth of mix was constructed, requiring about 1½ gallons of road oil per square yard. About two months after construction, the military authorities carried out a heavy traffic test on this section of road. This test consisted of various military vehicles, making 15 trips up and down the section at speeds up to 45 miles per hour. No damage whatever was caused to the surface, and the test afforded very conclusive evidence of the value of mix-in-place for the cheap and rapid improvement of desert roads.

Note.—In this article the question of drainage of the sub-grade and/or sub-soil of mix-in-place surfaces has not been mentioned, but as in any other form of road construction, satisfactory drainage is essential to the success of mix-in-place.

[*Note.*—It is hoped to publish a further article on the work carried out in Egypt in a later number.—EDITOR.]

Photo 1.

Photo 2.

Photo 3.

The mix-in-place method of road construction 1-3

Photo 4.

Photo 5.

Photo 6.

The mix-in-place method of road construction 4-6

Photo 7.

Photo 8.

Photo 9.

The mix-in-place method of road construction 7-9

Photo 10.

Photo 11.

Photo 12

The mix-in-place method of road construction 10-12

THE OVERLAND ROUTE FROM INDIA.

By CAPTAIN C. S. NAPIER, R.E.

SOME notes on the so-called overland route from India home through Bagdad and Constantinople (Istanbul) may be of interest to officers, especially those stationed in India. I left Rawalpindi on April 23rd, 1931, slept two nights (May 1st to 3rd) in Bagdad and one (May 8th) in Istanbul, and reached London May 13th, in a journey time of twenty days and not by the quickest route through Europe.

Season.—I had anticipated great heat in the Persian Gulf and Southern Iraq. On the contrary, a pleasant breeze gave us a perfect passage from Karachi to Basra, and I understand that this holds usually until the end of April: in May, the thermometer climbs high. From Basra to Bagdad, also, the journey, though warm, was not nearly so unpleasant as the Lahore–Karachi run skirting the Sindh desert a week earlier. From Bagdad conditions were ideal.

Information.—The agent for the Government Railways of Iraq, Amarchand Building, Ballard Estate, Bombay, will furnish full information as to the overland route. I met also with great courtesy in the headquarter offices of the Iraq railways in Bagdad. In Istanbul the agency of Messrs. Cook & Sons arranged my onward rail tickets and passport *visas*. Passport *visas* are required for Iraq, French Syria, Turkey and the smaller European countries. The three first named can be obtained without difficulty in India, but the remainder are best secured in Istanbul. Transit *visas* can be obtained at the frontier stations on the Simplon Orient Express if the traveller makes no halt in Istanbul.

Cost.—The following is a brief analysis of my own expenditure. First class from Karachi to Basra is something of a luxury and the figure for excess luggage (I took one uniform case) can be reduced to *nil* if no registered luggage is taken, *i.e.*, suit-cases only. The free allowance is small from Kirkuk and *nil* (for luggage in the van) beyond Istanbul. I should put £70 as the minimum figure for the whole journey in reasonable comfort.

ANALYSIS OF EXPENDITURE.

	£	s.	d.	
Tickets, including seat reservation :—				
Rawalpindi—Karachi	2	11	0	1st class on Form E.
Karachi—Basra	21	6	0	1st class.
Basra—Istanbul	20	19	0	2nd class *wagon-lit*.
Istanbul—London, *via* Cologne	19	7	0	2nd class (*wagon-lit* to Belgrade).
	£64	3	0	
Passport *visas*	1	11	0	
Excess luggage	5	1	0	
Travelling expenses	18	12	0	
Total ...	£89	7	0	

These travelling expenses include £2 sight-seeing in Istanbul with a Cook's guide, and a fine of four shillings for boarding the train in motion when starting from a wayside station in Turkey.

Hotels.—I stayed at the "Claridge" in Bagdad: there are two or three of the same standard—not a very high one. At Istanbul I can recommend the "Pera Palace," a hotel on the grand scale but not immoderately expensive. Meals on the *wagon-lit* trains are rather dear (in addition to the sleeping-car attendant's tip), but the food is excellent, especially on the Nisibin–Haydar Pasa section.

Route.—I have added as an appendix my own route and times in sufficient detail to give the frontier stations and an indication of the sections traversed in daylight. As far as Haydar Pasa there are few alternatives. I slept at Kirkuk instead of taking the night train, because Bagdad, a disappointing city, needs no more than one day. One could make the desert crossing from Bagdad to Damascus by the Nairn motor-cars and rejoin the normal route at Aleppo. Beyond Istanbul there is a choice of trains and beyond Belgrade a considerable choice of routes. As I had gone home from Palestine after the War by the Simplon-Orient route, I now took a more northerly course. You have to weigh Vienna, Budapest, Bavaria and the Rhine against Zagreb, Trieste, Venice, Milan and the Alps.

The Journey.—The Persian coast presents the same barren, inhospitable aspect as the more familiar shores of the Red Sea, but in the distance derives beauty from the shifting effects of light. We entered the Gulf at dawn, passing close off the rocky spur of Arabia: but one anchors too far out to see much of Bushire. We crossed the bar at Fao after dark and at dawn were still ascending the Shatt el Arab between interminable palm-groves.

Southern Iraq is monotonous and dusty, but one passes within sight of Ur and Babylon. I do not recommend a visit to these ancient cities unless excavation is actually in progress. The best finds from Ur are in the Bagdad museum. Northern Iraq bears the impress of two staple products—wheat and oil—and little else.

Over dry roads the Kirkuk–Nisibin section was comfortable and interesting, especially on the desert margin west of Mosul. During the short spring these wide, undulating plains afford grazing for thousands of camels, to which, on approaching the French frontier, succeeded millions of locusts crawling and hopping across the track, a portent of evil for the agriculturist.

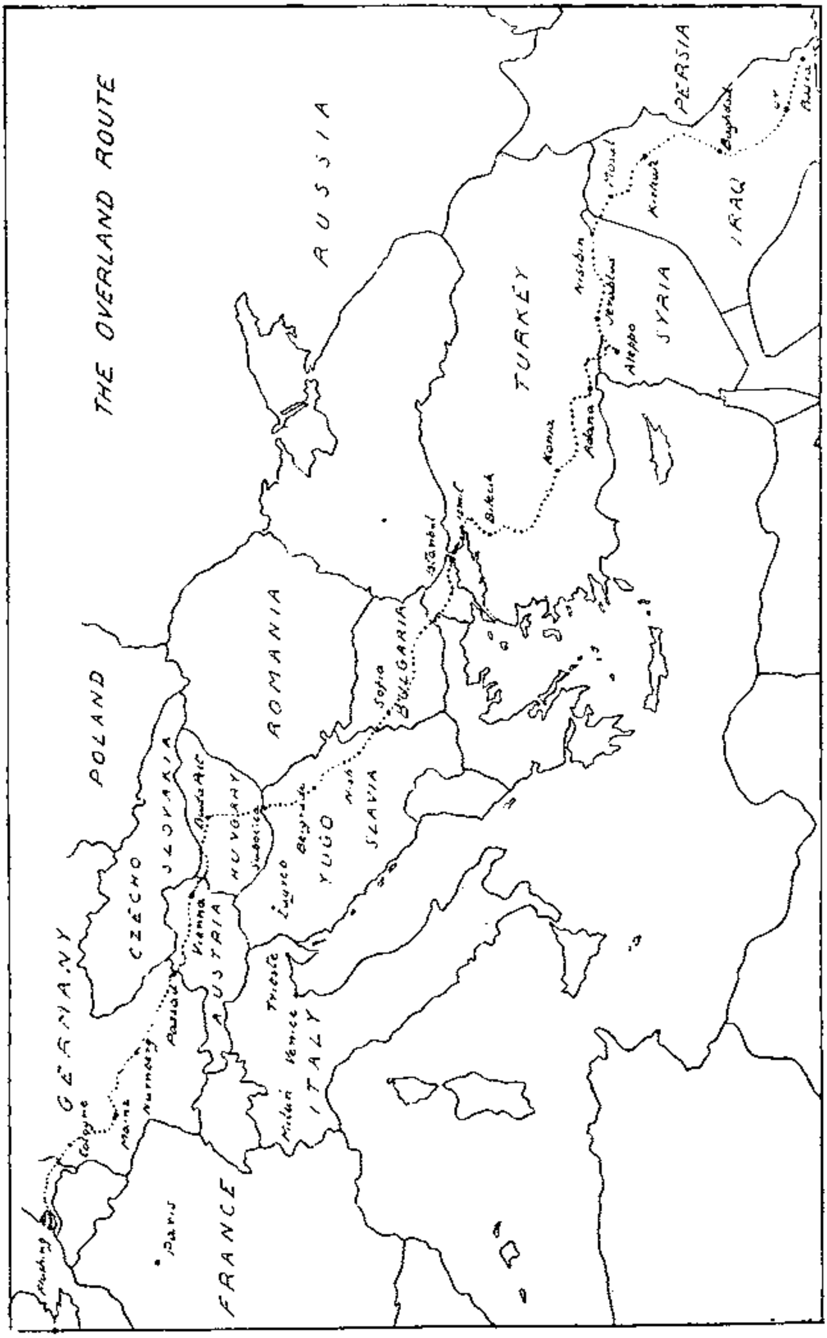
The Nisibin–Aleppo line is itself the Turco-Syrian frontier. Turkey is in possession of the railway track and offices, but at the stations both French and Turkish frontier guards trudge up and down or yawn at each other across the metals. The solidity of construction along this line is explicable by its political and strategic inception before the War. The German-built locomotives and rolling stock are still lettered "Baghdad." Progress even by the Taurus Express is leisurely along this section, but pleasant enough. Though withered brown in summer, the short turf is green and starred with small flowers in spring. The citadel at Aleppo, with walls weathered to a deep orange, is worth a visit during the two hours' wait.

The passage of the Taurus range is impressive, though marred from the scenic point of view by miles of tunnel at the wildest point, a narrow chasm cleft in the wall of rock. The descent from the Anatolian plateau a day later is equally fine and it is worth the effort to be up by 6 a.m. for the narrow gorge below Bilecik. Cliffs of grey rock rise sheer from the grassy banks of a swift-flowing stream fringed by shrubs and trees which must live in almost perpetual shadow. The morning had been cold with drizzling rain, but by 8.30 a.m. Mediterranean sunshine was breaking the grey Anatolian skies. The line skirts first a peaceful blue lake and then the gulf of Ismit: photography is not permitted here, Ismit being a naval base. Constantinople is still a superb spectacle.

Nothing brings home the new map of Europe so clearly as to traverse it without a check. Within 26 hours—from Uzunkopru to Passau—I crossed six frontiers and passed through four capital cities. One realizes the actuality of international problems as one sees the new villages built in Eastern Thrace by Greek peasants repatriated under the Greco-Turkish exchange of populations; the proximity of Sofia to the restless western frontier of Bulgaria; and the characteristic farmsteads of the black-earthed Hungarian plain lapping far over the southern frontier of Hungary, a reminder of the minority problems in Central Europe.

For those who prefer sea travel, deck-quoits and bridge, the overland route is long and tiring. For those who love to plot imaginary travels it is a wonderful experience.

Note.—An article, "Overland to India in 1907," was published in *The R.E. Journal*, March, 1932.


THE OVERLAND ROUTE
RUSSIA
POLAND
ROMANIA
GERMANY
CZECHO
SLOVAKIA
HUNGARY
AUSTRIA
YUGO
SLAVIA
BULGARIA
TURKEY
SYRIA
IRAQ
PERSIA
FRANCE
ITALY
Paris
Flushing
Cologne
Mainz
Nurnberg
Passau
Vienna
Budapest
Subotica
Belgrade
Nish
Sofia
Trieste
Venice
Milan
Istanbul
Konia
Adana
Aleppo
Nisibin
Mosul
Kirkuk
Baghdad

APPENDIX.

Rawalpindi	dep.	11.10 p.m.	April 23	
Karachi	arr.	8.5 a.m.	,, 25	
	sail	10.0 a.m.	,, 26	by s.s. *Varsova* to Basra.
Basra	land	7.30 a.m.	,, 30	
	dep.	10.0 p.m.	,, 30	
Ur		7.0 a.m.	May 1	
Bagdad (West) ...	arr.	7.0 p.m.	,, 1	
,, (North) ...	dep.	7.10 a.m.	,, 3	
Kirkuk	arr.	6.10 p.m.	,, 3	
	dep.	9.30 a.m.	,, 4	by car to Nisibin.
Mosul	arr.	4.0 p.m.	,, 4	
	dep.	9.0 a.m.	,, 5	
Uglat Post		12.15 p.m.	,, 5	Iraq frontier.
Demir Kapou ...		2.30 p.m.	,, 5	French Syrian frontier.
Nisibin	arr.	4.30 p.m.	,, 5	Franco-Turkish frontier.
	dep.	8.50 p.m.	,, 5	
Cobanbey	arr.	1.20 p.m.	,, 6	Turkish frontier.
Akhterine		2.30 p.m.	,, 6	French Syrian frontier.
Aleppo...	arr.	4.30 p.m.	,, 6	
	dep.	7.10 p.m.	,, 6	
Adana		6.0 a.m.	,, 7	
Konya		3.50 p.m.	,, 7	
Bilecik...		5.50 a.m.	,, 8	
Ismit		9.20 a.m.	,, 8	
Haydar Pasa	arr.	12.0 noon	,, 8	
Istanbul	dep.	6.50 p.m.	,, 9	
Uzunkopru		3.30 a.m.	,, 10	Turkish frontier.
Pythion		4.0 a.m.	,, 10	Greek frontier.
Svilengrad		7.30 a.m.	,, 10	Greek-Bulgarian frontier.
Sofia		7.0 p.m.	,, 10	
Dragoman		8.10 p.m.	,, 10	Bulgarian frontier.
Caribrod		9.30 p.m.	,, 10	Jugo-Slav frontier.
Belgrade		6.0 a.m.	,, 11	
Subotica		11.30 a.m.	,, 11	Jugo-Slav frontier.
Kelebia		12.30 p.m.	,, 11	Hungarian frontier.
Budapest		4.10 p.m.		
Hegyeshalom		7.40 p.m.	,, 11	Austro-Hungarian frontier.
Vienna (Ost) ...	arr.	9.10 p.m.	,, 11	
,, (West) ...	dep.	11.0 p.m.	,, 11	
Passau		5.30 a.m.	,, 12	Austro-German frontier.
Cologne	arr.	5.40 p.m.	,, 12	
	dep.	7.20 a.m.	,, 13	
Kaldenkirchen ...		9.10 a.m.	,, 13	German frontier.
Venlo		9.20 a.m.	,, 13	Dutch frontier.
Flushing	arr.	12.40 p.m.	,, 13	
	sail	1.30 p.m.	,, 13	
Harwich	land	7.10 p.m.	,, 13	
London	arr.	9.30 p.m.	,, 13	

ENGINEER TRAINING, PETAWAWA, 1931.

By CAPTAIN A. J. KERRY, R.C.E.

IT has been suggested that it might be of interest to R.E. officers to hear a little about the Sapper training in Canada during the summer of 1931.

The training was largely to test the efficacy of two revivals, the 1st (Fld.) Coy. R.C.E., and collective training for the field companies, C.E. The first ceased to exist in theory with the reorganization of the Permanent Force in 1920, but in fact the field and fortress companies, R.C.E., came to an end during the 1914–18 War. The last collective training of field companies, C.E., was in the summer of 1914, immediately prior to the War. Hence we were allowed to carry out our training even though nearly everybody else had theirs cancelled.

Petawawa Military Camp is situated on the Ottawa River, about 110 miles above Ottawa, at the junction of the Ottawa and Petawawa Rivers. Although used as a training ground for all arms of the Permanent Force, it is primarily known as the summer camp for all mobile units of the N.P.A.M.* artillery in eastern Canada. The ground is in the main very sandy and covered with a coarse twitch grass. A large proportion of the area is wooded with evergreens. There is good rail, road and water communication with Ottawa. Most of the main road is paved and the distance can be covered easily in two-and-a-half hours.

The training period was the inside of two weeks, one week for the collective training and the second for the remainder of the camp school. Training strengths were very skeleton, about twenty all ranks to a field company. There was also a small detachment from a field troop and about twenty candidates for the school. In all we had on parade, including P.F. personnel, about 150 all ranks.

* Non-Permanent Active Militia.

The following units attended :—

Unit.	*Station.*	*Distance from Petawawa.*
1st (Fld.) Coy., R.C.E. ..	Halifax, N.S. ..	1081 miles.
1st ,, Troop, C.E. ..	Hamilton, Ont. ..	420 ,,
2nd ,, Coy., C.E. ..	Toronto, Ont. ..	380 ,,
3rd ,, ,, ,, ..	Ottawa, Ont. ..	119 ,,
4th ,, ,, ,, ..	Montreal, P.Q. ..	231 ,,
7th ,, ,, ,, ..	London, Ont. ..	495 ,,
8th ,, ,, ,, ..	Toronto, Ont. ..	380 ,,
16th ,, ,, ,, ..	Montreal, P.Q. ..	231 ,,

From the above table it may be seen that transportation expenses had a considerable amount to do with the smallness of the training strengths. Units arrived in full marching order but brought no other equipment. All stores and training equipment had been collected in the camp engineer's stores. The camp equipment was taken on charge by the school and tents erected by the P.F.* advance party. No engineer messes were run, due to the small training strengths, all ranks being divided up amongst the Gunner messes. It is hoped to run Sapper messes in the future.

The training plans were drawn up some months ahead by the school commandant, Major F. R. Henshaw, M.C., R.C.E., under the orders of the Director of Engineer Services. To put the finishing touches to these and to make sure that the necessary stores and equipment were on hand, the officer commanding, I and three warrant officer instructors reported at Petawawa on the 28th of July. Very little trouble was encountered, due to the care with which the officer commanding had made his plans and to the help given us by the camp engineer and the camp ordnance officer. No small part of what success we had was due to the assistance of the former, Major (Q.M.) C. Shergold, M.C., D.C.M., R.C.E., who joined the R.E. about 1887 and later transferred to the R.C.E. The 1st (Fld.) Coy., R.C.E., under Lieut. G. Walsh, R.C.E., turned up about dawn on August 1st, and very rapidly whipped the lines and stores into shape.

The C.E. Units arrived in two groups, one at 3.43 a.m. and the other at 5.02 a.m. on August 3rd. They had detrained and marched the two miles into camp by seven o'clock. By nine they had been detailed to battery messes to feed, had breakfasted, drawn camp stores and working clothes, including large straw sunhats, and were on parade ready for fieldworks.

For the purposes of training we had five-and-a-half days. It was decided to divide the field engineering up into four sections and devote a day to each. These sections were :—(*a*) bridging ; (*b*) water supply

* Permanent Force.

and communications; (*c*) demolition; and (*d*) field defences. It was, of course, impossible to touch on anything but the most elementary outline of this work. The fifth day was given over to a collective scheme and the remaining half-day was kept to deal with odd trifles as they arose. The C.E.s were divided up into three groups by units, including the school, each in the charge of a R.C.E. subaltern, assisted by a warrant officer instructor. The remaining R.C.E. personnel were divided up among these groups to work with the C.E. personnel.

Our time-table for the first four days was roughly:—réveillé, 6 a.m.; drill parade, 7.30 a.m.; works parade, 8.30 a.m. to 12.15 p.m. and 1.30 p.m. to 4.30 p.m. The drill parade was handled entirely by the C.E. officers. On the works parade all officers over the rank of 2nd-lieutenant were taken on schemes by the school commandant. The remainder came under the second-in-command and were marched to the works site, about two miles away, in battle order over canvas clothing. It was amazing to note the rapid improvement in the marching. A sketch of the area is attached to this article.

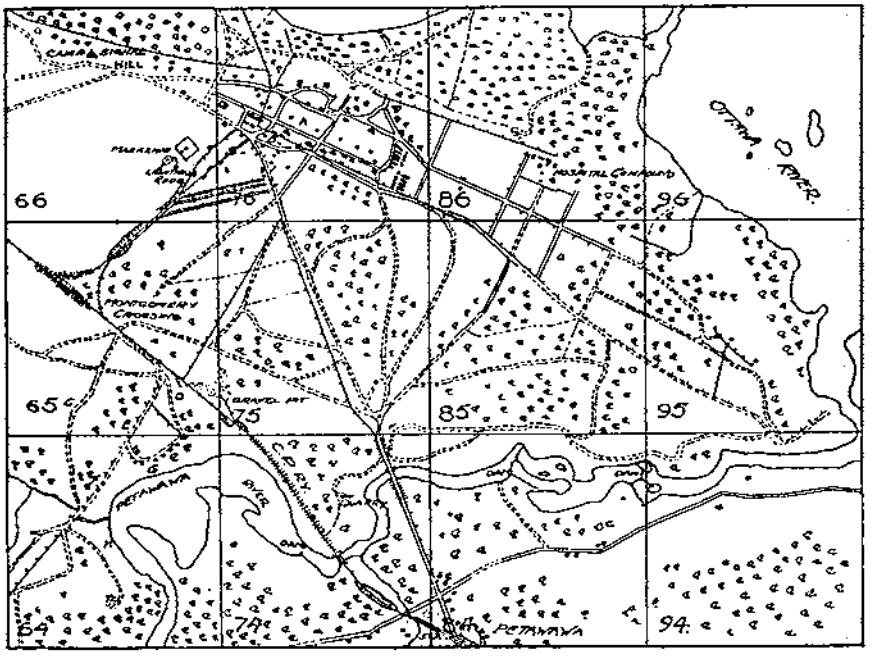
It was considered advisable to return to camp for dinners in the middle of the day. For this we used two R.C.E. trucks (one and one-half ton Ford lorries), and I have seen as many as forty men on one of these. These trucks were controlled by the camp adjutant and quartermaster. They were also used on the officers' schemes and to transport stores to the works. Other transport available included teams, the occasional R.C.A.S.C. lorry and a Fordson tractor. The stores and transport job was exceptionally well handled by Lieut. N. J. W. Smith, R.C.E., who had had no previous experience in this type of work.

Under the heading of bridging we dealt with the Kapok assault bridge, trestles and barrel rafts. A certain amount of work was also done with the old Weldon trestle. Unfortunately, we were not able to get any pontoons or other post-war bridging equipment. Water-supply work consisted of the erection of a series of water points, in which particular stress was laid on concealment from aerial observation. In the communications line we started to make a road through the bush for 30-cwt. six-wheelers. The demolition consisted mainly of road blocks, made by means of small craters blown by auger-hole charges and by felling trees. Two tunnelled charges were also attempted, but the behaviour of the sand when we started to break out from the shafts caused these to be abandoned. Work was also done on the connecting-up and placing of charges. In field defences we made a start on the entrances to a tunnelled dugout, and constructed some camouflaged machine-gun emplacements. It was found that the sandy nature of the soil more than doubled the rate of digging. The soil was dumped in connection with the road scheme.

The parties were also practised in tracing out a platoon strong-point and in the erection of tactical wire. All this work was connected together in one general narrative, the applicable parts of which were issued to all ranks on each job to stimulate interest and to show that there really was some method in our madness.

On the fifth day we did a scheme with a composite field company, one section consisting of R.C.E. and three sections of C.E. personnel.

PETAWAWA CAMP AREA.



A.—Engineer Lines (temporary).
B.—Camp Engineers Compound.
C.—Field Defences.
D.—Road Blocks.
E.—Demolitions—Road Construction.
F.—Water Supply.
G.—Practise Bridging.
H.—Bridging Scheme.

The scheme was the forcing of a crossing at the point " H " on the sketch. Parade was called at 03.00 hours and the company moved by sections on a night march to the site. Stores had been taken up as near as possible the previous night and the route marked. This march was very well carried out by all parties except the trucks towing the tool carts, which could be heard for miles. The Kapok bridge was assembled in a clearing and carried down and launched by the C.E.s, the R.C.E.s providing the covering party. Due to the unexpected behaviour of the current, the length of the bridge, 300 ft., and the comparative inexperience of the working party, the launching

was not as successful as had been hoped for, but a lot of useful experience was gained. After this bridge was across and finally straightened up, the company breakfasted by sections at a temporary cookhouse. The next step was to detail one section of C.E.s to build a flying bridge with a barrel raft to carry Carden Loyds and similar transport, while the rest of the company set out to build a medium bridge, the R.C.E. section at one end and the two remaining C.E. sections at the other. This bridge consisted of cribs and frame trestles of local material, with four 12" R.S.J.s per bay of 16 ft. with 3" x 9" decking. In view of the shortness of time only five bays of bridge were completed. Work ceased at 16.30 hours and all ranks returned to camp by march route, singing lustily.

The final morning was spent in further experiments with the assault bridge, which now worked successfully, and the recovery of non-expendable stores from the bridge site. A detachment dug two shafts about 7 ft. deep, put 100 lb. of two experimental gunpowders in each and set them off electrically. The sandy soil produced a most amazingly good effect and a light breeze aided to give all the effects of a smoke screen.

In the afternoon the R.C.E. beat the C.E. at football, but a soft ball game had to be cancelled due to rain. The C.E. units returned to their stations by the 12.11 a.m. train on August 9th, while the R.C.E. and the school remained on for another week.

All the candidates at this school had passed a theoretical course at their own stations before attending the camp school, so we did only the practical end of the work, which was in reality a rehash of the previous week with considerably more detail, finishing up with a day of oral examinations. During this time the R.C.E. personnel were employed in cleaning up the works area, recovering stores and tools and in general leaving everything in ship-shape order to carry on with next year.

On the whole we consider that we made a reasonable success of the job. We know that the C.E. people enjoyed it, and I think that all ranks who attended hope very much to be back there again next year.

1.—The R.S.M., R.C.E., shows 'em the way to do it.

2.—Camouflaged M.G. emplacement.

Engineer Trg. Petawa, 1931 1-2

3.—Bridging scheme.

4 —Pier and approach under construction. Flying bridge.

Engineer Trg. Petawa, 1931 3-4

SURVEY SIDELIGHTS.

IV.

By CAPTAIN J. C. T. WILLIS, R.E.

IN England the process of engaging servants is simplified, so my wife tells me, by the fact that you can write to the last employer and obtain a "character" of the cook (or if you are very senior—the butler or footman) of whose services you wish to avail yourself. Right. Then you get a letter back and by reading between the lines and assuming most of the vices which are not specifically ruled out, you get a shrewd sort of idea of what you are in for. And even then you are generally surprised.

But in Malaya all this is different. For one thing, in England, one has the privilege of arranging the size of one's household to suit the depth of one's overdraft. In Malaya, where practically all servants are Chinese, this is a matter which is decided for one by the Chinese Servants' Trades Union Headquarters, who assess your pay by the rank you hold and decree that such a one as yourself must employ a definite number of servants. If you attempt to manage with less, one of two things happens. Either your entire staff reports that it is collapsing from overwork and gives in its notice simultaneously, or else, if the servants concerned do try to carry on with the work, they are quietly "beaten up" by the Union as being blacklegs. A step in rank always means that the staff which supported the needs of the household of, say, a Captain, is totally inadequate to do identical work for the same individual as a Major. Such things must be accepted with a shrug. Hence the expression "the unchanging East."

When a servant is discharged, a new one is apt to arrive to fill the vacancy without any reference to the employer and it is some days perhaps before he realizes that the change-over has taken place. On other occasions, various candidates (generally produced by the outgoing domestic, who takes his commission off the successful applicant) arrive on one's doorstep, each one armed with "chits" alleged to be signed by his previous employers (all of whom appear since to have left the country), and one and all testifying to qualities which would make an archangel blush. Such chits, one imagines, are always available for applicants in the local bazaar, and may be hired at rates varying with the degree of virtue expressed in them. A small extra

charge is sometimes made and, if possible, collected if the production of the " chits " on hire results in the applicant landing the job.

I firmly believe that all " good chits " given to departing servants in all good faith by their late employers end up in this fund, and that all those worded in terms so guarded as to make " to whom it may concern " hesitate, are incontinently destroyed. It is no good giving a bad chit to an unsatisfactory servant unless the meaning is so carefully veiled as to be incomprehensible to the native mind. And this takes some doing !

Such a *cri du cœur* as " The bearer has been my cook for the past six months—he leaves on account of illness (mine !) " is hardly likely to get very far. A more subtle one, which did actually convey the required impression without being spotted, was: " As I could not avail myself of the services of Ananias, I engaged this boy, who filled the bill admirably."

" Gives no trouble and takes none," which exactly sums up the Malay character, would stand but little chance; the cleverest of them all, however, was never spotted and may be presumed to have fetched a high price in the bazaar.

" Anyone who wants the services of a really hardworking, trustworthy boy is strongly recommended to give the bearer a berth. A good wide one."

In this connection there is an excellent leg-haul that the Chinese servant can produce for his master's benefit. One day you may find in your kitchen, assisting the cook, a lad who corresponds in some respects to a boot and knife boy. This is the first intimation you have had that your staff has been increased and on your enquiring as to the why and wherefore, you are told, " This, sir, is my brother —he has come for no wages, simply because he has a kind heart." There is, of course, a catch in this, and you do not, as a rule, spot it right away. The next move in the game is that the lad makes himself so useful about the house in a hundred little ways that, on the application of the cook, you grant him some nominal salary—say three dollars a month. This goes on for a few months and then, without warning or comment, the lad fades away and you are left wondering what the catch was, anyway.

Now look at it from the cook's point of view. Firstly, he has had an apprentice to his trade, learning his job as a future " white man's cook " in your house. For which privilege the lad or his parents have been paying your cook quite substantially.

Secondly, the cook has induced you to pay the lad wages, which have instantly found their way into his own capacious pocket.

And, finally, the cook has been able to sit back at his ease while the lad, who is paying twice over for the privilege, does his work for him. And *that* takes some beating !

MEMOIR.

LOUIS BRENNAN, Esq., C.B.

IT is one of the characteristics of the Corps of Royal Engineers that they have always been glad to welcome the help of experts from other branches of their profession. A long list might be compiled of such "Friends of the Corps" who have assisted in developing the very numerous applications of Engineering Science covered by the term Military Engineering. Among all our friends the name of Louis Brennan is one of the best known, not only for his long association with one form of our work, but for his personal friendships with several generations of R.E. officers.

Among Brennan's well-earned distinctions he always valued very highly his selection in 1906 as an Honorary Member of our Institution.

Louis Brennan was the son of Thomas Brennan, a merchant of Castlebar, Ireland, where Brennan was born on 28th January, 1852. When he was nine years old his father and family emigrated to Melbourne, Australia, where Brennan was educated. With a strong bent for invention he tried his hand first at various trades and occupations, including photography, stage scenery painting and engineering. Among other jobs he successfully undertook the construction of a clock for Melbourne Town Hall. Finally, he was articled to a Scotch engineer of the name of Smith, and it was while in Mr. Smith's employ that he conceived the idea of the dirigible torpedo with which his name will always be associated. Mr. Smith was a member of the Victorian Parliament and later gave Brennan valuable assistance in bringing his invention to the notice of the Home Government.

The principle of the torpedo was based on an observation by Brennan that a reel of cotton, placed so as to roll on the floor, can be made to move away from the operator when the thread is pulled from the underside. He applied this idea in a very ingenious manner by using two wires wound on reels inside the torpedo, which when pulled out operated two screws driving the torpedo. Also by winding one wire faster than the other, he was able to work a steering mechanism, and so to steer the torpedo with great precision.

This was coupled with a gyroscopic attachment which kept the torpedo running at a uniform depth. The application of these principles was most ingenious and every part of the apparatus from the electrical communication between the operator and the engine-room, the engine, the launching way and the torpedoes, owed much to Brennan's mastery of detail, and the skill which enabled him to overcome practical difficulties.

The torpedo was patented in 1877, a working model made and tried in Australia and a small company was formed there to finance the invention. It was then offered to the Admiralty in London with a strong recommendation from the local Government. The Admiralty, however, thought it was better adapted to local defence, so, in 1881, it was passed on by the War Office to the R.E. Committee for report.

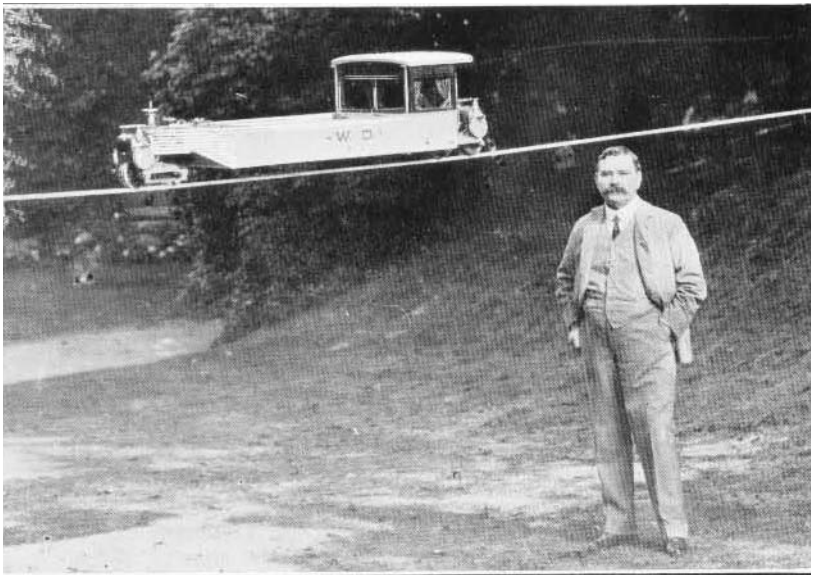
Brennan came to England in 1882 and was accompanied by Mr. J. Temperley and, after a series of most careful trials and reports by various influential committees,* the torpedo was purchased by the Government in 1887 for the sum of £110,000, payment being spread over five years, during which time Brennan, Temperley and a foreman, who knew the secret, were employed at fixed salaries to supervise the manufacture of the torpedo. The £110,000 had to be shared with Mr. Temperley and the Australian company.

The full-scale trial of the torpedo which finally proved its value took place in the Needles Channel, off Fort Victoria in the Isle of Wight. It was witnessed by a distinguished company, which included the Secretary of State for War, many Members of Parliament and senior officers from the Admiralty and War Office. The target was an old wooden ship, which was towed past the fort at a range of 1,200 yards. The method of using the torpedo was to estimate the pace of the attacker and to launch the torpedo so that, using the minimum steering, it would cut across the track of the attacking vessel when abreast of the installation. Brennan was himself in charge as operator and whether he launched a little late, or whether, as he himself afterwards claimed, he did it deliberately, the torpedo passed astern of the target! Brennan at once turned the torpedo nearly at right angles to its course and put on speed so that it overhauled the target ship and struck it on the side farthest from the operator! The explosion was completely successful, the target ship disappeared in a cloud of smoke and when this cleared away there was nothing left floating but a few timbers.

Although the amount paid for the torpedo was a large sum, especially for those days, the expenditure was amply justified, as the torpedo kept its place in our defences for twenty-one years and the secret never leaked out, so that no foreign nation produced a similar weapon.

In estimating the value of the torpedo at the time it must be remembered that, in 1887, the effective range of gunfire from a ship did not much exceed 2,000 yards, while the Whitehead torpedo with which our ships were armed had a maximum range of about 400 yards and was very erratic at this distance. The Brennan had an effective range of 2,700 yards, ran at a speed at least equal to that of any attacking ship, and had weight enough to carry it through the torpedo netting with which ships were then defended.

* Details of the negotiations are given in some detail in *History of Submarine Mining in the British Army*, published by the Institution of R.E. in 1910.



Brennan model mono-rail

Louis Brennan, ESQ, CB

The final withdrawal of the torpedo from our defences in 1907 was one of the changes brought about by the great increase of the range and accuracy of naval gunfire and naval torpedoes.

It is noteworthy that the improvements in accuracy of the Whitehead torpedo have been mainly due to the use of the gyroscope. Whether or not this arose directly from the work of Brennan it is certain that the latter should have the credit of being the pioneer in this branch of invention.

Brennan held the appointment of Superintendent of the Brennan Torpedo Factory till 1896, when his services were retained as Consulting Engineer in connection with the use of a thicker wire in the torpedo. As the thicker wire occupied more space, the effective range of the torpedo was reduced to 2,000 yards, but this was sufficient. But the increased strains necessitated a remodelling and strengthening of every part of the torpedo without altering its outer shape and form. It was here that the genius of Brennan showed at its best; as each difficulty was found he was ready with a solution, sometimes quite simple, often original, always effective.

To carry out the experiments with the thicker wire, an old trawler, the *Sir Howard Elphinstone*, was fitted with launching gear and winding engines designed by Brennan, and proved that the torpedo was well adapted as a weapon to be used on board ship. In 1901, trials took place between the *Sir Howard Elphinstone* and a torpedo boat towing a small buoy as a target, and proved quite conclusively that a ship, armed with the torpedo and stationed off the Nore, could prohibit hostile entrance to either the Thames or Medway.

In 1892, Brennan received the C.B. (Civil) in recognition of his services.

The same year he married Miss Anna Mary Quinn, from his old home town of Castlebar.

Although Brennan was giving the whole of his time to the torpedo work, his brilliant intellect was always busy, sometimes to suggest some mechanical improvement for the every-day work around him, or some flash of thought which might prove of general utility. One of his intimate friends writes that "had Brennan developed some of his small inventions he would have ranked as one of the benefactors of the world."

One of his earliest efforts in the early 'eighties was a form of moving photograph which anticipated the present film.

Another friend writes: "Louis Brennan had little or no mathematical knowledge, but he seemed to possess a sixth sense which enabled him to solve experimental problems of great mathematical complexity."

He was especially interested in the behaviour of the gyroscope, about which his knowledge was almost uncanny, and his next large invention, the "Monorail," depended for its success on the use of a pair of gyroscopes. As its name implies, this invention was of a

railway carriage which could run on one rail without toppling over, and maintain its stability round curves or up or down gradients. The advantages of such a form of railway were obvious, especially in undeveloped country, and as the invention grew it attracted a great deal of public attention and interest.

The first patent was taken out in 1903, and in 1906 a working model was completed which ran on a small line in the garden of Brennan's house at Woodlands. On 8th May, 1907, when the model had been perfected, Brennan exhibited it at a conversazione of the Royal Society in Burlington House. The writer of this memoir had the good fortune to be present and well remembers the interest which was shown by a packed audience, who thronged the Lecture Theatre. Brennan was not a good after-dinner speaker but when he knew his "subject," he spoke clearly and well. He demonstrated how his model would stand up on its own wheels and showed its flexibility round curves by making it run on a length of steel cable which he laid in circles and a figure of eight on the small stage. Finally, he dispatched the model on a journey along a rail which had been fixed round the walls of the room at a few feet below the ceiling. The model mounted a steep incline and progressed steadily round the room, taking the sharp curves at the four corners without any difficulty, and finally returning to its inventor, like a well-trained dog to his master.

So many people wanted to see the invention that Brennan had to repeat his lecture the same evening to a second, equally crowded, and equally enthusiastic audience.

Following this, Brennan was able to obtain financial assistance from the War and Indian Offices and also a lakh of rupees from the Kashmir Durbar in view of the possible use of such an invention in developing a mountainous country, and with this assistance a full-sized model, weighing 22 tons, was constructed and tried in the grounds of the disused Brennan Torpedo Factory at Gillingham.

This model was shown to the Press in November, 1909, and was run at the Japan-British Exhibition at the White City, from May to October, 1910.

While, however, the invention itself was completely successful, the application of this system to run a railway on a commercial basis gave rise to some difficulties, and would have required a good deal of expensive experimental work before these difficulties could be surmounted. The original Government grants were now expended and Brennan, who had large ideas of the commercial values of his invention, failed to come to terms with a syndicate who approached him with an offer of funds. He thus found himself unable to continue his experimental work and had to drop the invention.

This failure hit him rather hardly, both personally and financially.

He next turned his attention to the flying service, and evolved an

idea for a helicopter. On the outbreak of war he offered his proposal to the Board of Inventions, and received assistance from them, and in 1916, when the Ministry of Munitions was formed, he was attached to this Ministry, and later to the Air Ministry for confidential aircraft research work. For various reasons his helicopter was not completed till after the War, and when it was tried, about 1925, it was found that though it had adequate lifting power and was mechanically sound, the aerodynamic controls and the landing arrangements were not satisfactory. Further experiments were cut short in 1926 by the increasing financial stringency, and Brennan again had to turn his attention to other inventions, some of which are still alive and are being developed by his friends.

Had his business aptitude been the equal of his inventive genius, he might have risen to any position, but like many inventors, his interest in an invention lay more in the breaking of new ground than in the monetary profit which success might bring. In his leisure moments he was a charming and entertaining companion with an enormous fund of anecdotes. He was never so happy as when entertaining friends in his own house. He was a highly-skilled amateur conjuror, both with tricks requiring some mechanical apparatus and also in real sleight of hand. He could keep a whole messroom interested after dinner with coin tricks, producing seemingly unlimited quantities of half-crowns from every possible or impossible place.

In spite of the financial worries and partial failures of his later years, he never lost his keen interest in life. Nothing was too small to interest him, and he undoubtedly owed much of his success to his habit of concentrating on even the smallest details.

He seldom or never took a holiday, and was working up to nearly the end of his life. His wife died in 1931, and his own health failing, he went to Switzerland to recoup, but died suddenly at Montreux, on 17th January, 1932, just before he had completed his 80th year.

W.B.B.

CORRECTION.

In the first memoir which appeared in *The R.E. Journal* for March, 1932, the caption to the photograph and the heading of the memoir should have read:

General Sir Reginald Clare Hart, V.C., G.C.B., K.C.V.O.,
Colonel Commandant R.E.,

and not as given therein. Sir Reginald Hart was awarded the higher honour of the G.C.B. in June, 1931.

This error is much regretted.

BOOKS.

(Most of the books reviewed may be seen in the R.E. Corps Library, Horse Guards, Whitehall, S.W.1.)

HISTORY OF THE GREAT WAR.

VOL. V.

Military Operations, France and Belgium, 1916. Compiled by Brigadier-General Sir JAMES E. EDMONDS, C.B., C.M.G., R.E. (retired), *p.s.c.* Maps and Sketches compiled by Major A. F. BECKE, R.A. (retired), HON. M.A. (Oxon). Macmillan & Co., Ltd. London. 1932. Price, with a separate Volume of Appendices and Case of Maps, 12s. 6d. net.

This volume deals with the first six months of Sir Douglas Haig's Command, from December 19th, 1915, to July 1st, 1916, and thus includes only the first day of the battle of the Somme.

Although there was no prepared offensive during the six months, the casualties —over 125,000 up to June 30th—are evidence that there was severe fighting. The heavy losses are explained by the fact that the period includes the first German phosgene gas attack on December 19th at Ypres; the loss and recapture of The Bluff in February and March, 1916; the fighting at the Hohenzollern Redoubt, and at the St. Eloi craters, in March; the German gas attacks at Hulluch, and on the Wulverghem front, in April, May and June; the fighting on the Vimy Ridge; and the attack on the Canadians at Mount Sorrel in June. Mining warfare also claimed its share.

These minor operations are described in some detail, General Edmonds explains, because they afforded valuable training and experience to the troops and the Staff who were destined to take part in the great offensive of 1916 on the Somme.

Some of the German attacks may have been intended to divert attention from the operations against Verdun and fix the British to their positions in the north; but although the last-mentioned certainly hampered Sir Douglas Haig's preparations for his own offensive, none induced him to change or modify his plans.

It is not out of place here to recall that at the time—the end of January, 1916—the French Command appeared slow to realize the imminence and full import of the German thrust at Verdun. British intelligence reports circulated during the last week of January, 1916, indicated the impending blow nearly four weeks before it fell. General Edmonds tells us that at the Allied Military Conference, on February 14th, Verdun was not mentioned; and that Colonel Dupont, head of the French intelligence, after being anxious about Verdun at the beginning of February, and then doubtful, had hesitated until February 11th to say more than that there was a heavy German concentration towards the fortress; it was not till February 19th that General Castlenau, now Chief of Staff to General Joffre, definitely informed Sir Douglas Haig that the Germans were about to attack Verdun. The attack was launched on February 21st, but it was not till March 3rd that General Joffre was convinced that it was not a feint to divert attention from the real blow elsewhere.

The Germans thus forestalled the Allies and upset their plans for 1916. The possibility of their gaining the initiative had not been overlooked by General Joffre. On December 8th to 10th the Allied Military Chiefs had met at Paris to discuss the Allied plans for 1916. By that date it was evident that the situation was not encouraging and a change of policy was obviously necessary if the War was to be won. The Conference unhesitatingly endorsed the principle that the War could only be

won on the Western Front, and it made certain recommendations which were discussed by the War Committee of the Cabinet in London, December 28th. Briefly the conclusions of the Committee were :—

1. From the point of view of the British Empire, France and Belgium remained the main theatre of war.
2. The British agreed to take part in co-ordinated offensive operations on the three principal fronts (France, Russia and Italy) in the spring of 1916. (Italy was not yet at war with Germany.)
3. An adequate force, estimated at eight divisions and garrison troops, should be left in Egypt for the defence of the country and the Suez Canal.
4. The operations already arranged to expel the Germans from East Africa should continue. The strength of the enemy was estimated at 2,000 whites and 20,000 native troops.
5. When Kut was relieved, operations in Mesopotamia were to be of a strictly defensive nature.

Before the Conference met it had already been decided to evacuate the whole of the Gallipoli Peninsula. Great pressure was brought to bear on the Government to augment the Franco-British forces already in Salonika, and the following arguments were put forward in support of the proposal :—

1. The occupation would facilitate the reorganization of the remnants of the Serbian Army by Italy in Albania and Corfu.
2. Pressure could be continued on Greece, and her shores denied to enemy submarines.
3. Rumania would not be over-run by the Central Powers.
4. Bulgaria, Rumania and Greece might be induced to join the Allied Powers.

As regards the date of the proposed offensives in 1916, it was calculated that it would take the Central Powers a month to transport twelve corps, 500,000 men, from east to west, or *vice versa*, so that all the offensives must be delivered within that period, to prevent the enemy moving his reserves to deal with each in detail. General Joffre stipulated that if enemy action demanded it, the Allies should be ready even earlier than early spring.

The British Official Historian attributes a great deal of the want of a settled policy and co-ordination in the British effort in 1914–15 to the fact that most of the Headquarter Staff of the Army, and especially of the General Staff branch, accompanied the B.E.F. to France in August, 1914. With an improvised staff the task of Lord Kitchener, as Secretary of State for War, was extraordinarily difficult. At no time during 1915 can it be said that the Imperial General Staff fulfilled its functions. England as usual "muddled through," and when some of the senior officers were brought back their experience in France perhaps made up in some measure for their absence from the War Office during the first eighteen months of the War.

General Edmonds takes this opportunity of paying a tribute to the memory of Lord Kitchener, and reminds us of the part he played during this difficult time, practically unsupported. He mentions the fact that he alone would have been acceptable to the Allies as Generalissimo of the Allied Armies at this juncture. It is believed, he tells us, that Lord Kitchener himself expected to be called to that position. His death in June, 1916, was an irreparable loss to the Empire; it assumes an even wider significance when we look back to the sacrifices of the British Army in the autumn of 1916, the Nivelle fiasco in the spring of 1917, the events in Russia in that year, and the disaster of March, 1918. For had Lord Kitchener accomplished his mission to Russia in June, 1916, and acquainted himself with the trend of affairs in that country and the storm brewing there, it is certain that no Englishman would have been fooled into imagining, as not a few persons in the drawing-rooms of London, and even Sir Henry Wilson, for a time did, that any brand

of revolution in Russia could do ought but harm to the Allied cause. For nearly two years after his death, there reigned, General Edmonds writes, in the Western theatre division of counsel and dispersion of power. At times, friction was only averted by Sir Douglas Haig yielding to France's demands to the utmost degree compatible with the safety of his forces.

After quoting the King's message to the army after Lord Kitchener's death, General Edmonds concludes: "Who can now doubt that but for this man and his "work Germany would have been victorious?" The Army will endorse his verdict despite the reiterated attempts of Sir John Fortescue and other writers to belittle his reputation as a soldier.

Having discussed at length the plans of the Allies for 1916, General Edmonds appends an interesting note on the German plans for that year and Verdun. Falkenhayn, after dealing with Russia and going to the aid of Turkey in 1915, was as confirmed a "Westerner" as when he prepared his original plans for 1915 on the Western Front, and was more than ever certain that the decision must be sought there. He considered that the British Empire was Germany's "arch enemy in this war," and that it was useless to strike at her in the East; for victories at Salonika, on the Suez Canal, or in Mesopotamia, would not help except for propaganda purposes in the Mahommedan world. He realized, in fact, that the British Fleet was still omnipotent. The French Army he regarded as "England's best sword." While demanding unrestricted submarine warfare to cripple Great Britain at sea, Falkenhayn, realizing that French resistance was weakening as a result of the heavily subsidized campaign of *défaitisme* in certain French newspapers such as *Le Bonnet Rouge*, decided that a knock-out blow might bleed her forces to death or lead to a revolution which would place the Government in the hands of men favourable to an immediate peace with Germany. It was, in his opinion, a choice between Belfort and Verdun; but, as General Edmonds points out, why the choice was restricted to the neighbourhood of two strong fortresses is not clear. The German Emperor endorsed Falkenhayn's eventual choice of Verdun, probably because the attack would take place in the area of the Crown Prince's army. General Edmonds calls attention in this connection to the curious fact, made public for the first time in the German Official History, that when Falkenhayn made his plans for a German offensive on the Western Front in 1915—plans that were rendered abortive by events in the East—he prepared for operations on the Aisne, near Roze, and between the Somme and Arras, and made no mention whatever of Verdun.

After referring to the Brusilov offensive in the spring of 1916, in south-west Russia, General Edmonds devotes the next two chapters to the expansion and reorganization of the B.E.F. between August, 1914, and July, 1916. He covers an immense amount of ground and leaves no subject untouched, from the organization of "Auxiliary Social Services" to "Graves Registration." Each note is a masterpiece in the art of condensing all that is essential on each subject. The notes on "The Press," "Recruiting," "Munitions," "Supply," and the "Ordnance Services," are of special value and teach many valuable lessons. General Edmonds is careful to give references to other publications where the reader can obtain further details.

There follows an instructive chapter on "Trench Warfare," in which is discussed the question whether the British Commander-in-Chief was right or wrong in ordering and encouraging the carrying out of frequent raids on the enemy's trenches. The first raid, it is believed, was carried out by a small party from an English regiment in December, 1914, but it was not till a British Columbia battalion of the Canadians carried out a most successful raid on the Second Army front in the winter of 1915 that raiding became a part of the regular curriculum of trench warfare. In that raid, carried out by 100 men, 70 were British born, many of them English public-school boys. The Colonel of the regiment was a newspaperman by profession, a hunter when he could find respite from work. It served

as a pattern for future generations; nothing was left to chance, every eventuality was foreseen, and the operation was practised over dummy trenches till each man knew exactly where to go and what to do. There is no doubt that confidence was gained by successful raids and the obtaining of identifications; but the difficulty of training the troops simultaneously was a real one. That training was needed and was neglected is a fact, and the troops paid the penalty when they found themselves faced by open warfare, even during the first day of the battle of the Somme.

On the events of that day, General Edmonds has some very trenchant criticisms to make. He is perfectly correct in his statement that it was a fatal error that the infantry had been ordered to cross No Man's Land at "a steady pace," instead of at the highest speed possible, although there was no creeping barrage to help them in this first stage. This and the failure to observe the principle of mutual assistance were the fundamental reasons for the general failure of the attack. It was only successful on the extreme right where the British troops had the advantage of the support of French heavy artillery. That the British artillery support was insufficient was due chiefly to defective ammunition, to which the number of unexploded shells bore witness. Counter-battery work, especially on the left flank, did not receive sufficient attention. The uninterrupted stream of shell from the neighbourhood of Adinfer falling all day on the trenches and No Man's Land in front of Gommecourt was proof of this, and accounted for almost as many casualties as did the German machine-guns during the two attacks of the 46th Division on the 1st July.

As to the results of the battle, "a mere comparison of casualties sustained," writes General Edmonds, "or even an enumeration of villages and ridges gained, presents, "however, no indication. The losses on the Somme staggered the Germans. In the "first 10 days they lost 40,167 men; in the worst 10 days at Verdun the total had "been only 25,928. Taking the net figures, in the five months (July–November) "the Germans lost 437,322 (average 85,000 a month); and at Verdun, in the first "six months, 281,333 (average 47,000 a month), and 336,831 in ten months." "The "morale of the German Army was shaken never to recover. There were other results. "General von Falkenhayn who realized that Germany could not win the war and "was fighting for a 'draw' in her favour was dismissed and replaced by Field-"Marshal von Hindenburg, with General Ludendorff as his chief assistant." In the end, this proved to our advantage for they decided to organize a chosen line of defence in rear, the "Hindenburg Line," and, in March, 1917, the divisions of the German Army on the Somme front slipped away to man it. This signified more than the giving up a little bit of territory. General Edmonds quotes General Hunter-Liggett, the Commander of the American First Army, who has pointed out what the retirement meant: "Had the German attack that was to come in March, 1918, "been launched from the old position rather than from the Hindenburg Line, the "Germans would have been in Amiens. That retreat, caused by the British successes "on the Somme in 1916, may well have saved the Allies from defeat in 1918, before "we could aid them in force."

It only remains to say that to condense what he has in one volume is only what we now expect from the British Official Historian. It is a remarkable achievement. He has relegated the Operation Orders, Orders of Battle and Memoranda to a smaller accompanying volume. The maps are as good as Major Becke has always provided, and there is a good Index. H.B-W.

THE EXAMINATION FOR ADMISSION TO THE STAFF COLLEGE.

By Lieut.-Colonel A. F. T. Wakely, M.C., *p.s.c.*, R.E.

(Sifton Praed. 2s. 6d.)

A very useful pamphlet of 36 pages dealing with all the stages of preparation for the examination. The contents include advice to the officer when he first decides to sit for the examination, advice on the best method of general and detail preparation

and helpful hints on the examination itself. The last chapter contains a list of books for the guidance of an intending candidate.

Methodical preparation is essential in attempting to cover so broad a syllabus, but for most candidates method is simple in theory and difficult in practice. It is as an aid to methodical preparation that this book will be found valuable.

While a warning against leaving preparation to the last moment is sound advice, the author's suggestion that preparation should start if possible when the candidate leaves Woolwich or Sandhurst may need some qualification. The intending candidate must first gain experience and learn his own job as an essential foundation for the work of preparation for the obligatory subjects. The sooner work on the voluntary subjects is started the better.

The author does not consider the services of a tutor essential and here opinions will differ. In the reviewer's opinion, a candidate should think twice before discarding the assistance of a tutor. In the reviewer's division at the Staff College all but a very small minority used a tutor in preparing for the examination and the majority would do so again.

While agreeing with the principle of hard work and a methodical programme, many successful candidates will disagree with the seven-days-a-week, 20-hour, programme suggested on page 19. Probably a 16-hour week *as a maximum*, with at least one day in the week free, is the most that most constitutions will stand in addition to normal work.

On matters of detail the book covers the ground very thoroughly. A large number of questions in all papers call for an answer in the form of a short half-hour essay, and the importance of practice in this form of writing might have been stressed.

On the subject of saving time in the examination itself (Chapter IV), the values of a rapid system of marking up situations on maps is not mentioned. Whether the system be coloured chalks, glassheaded or flagged pins, is immaterial provided the system is clear and rapid and the candidate has accustomed himself to do it by long practice.

The use of ink other than black is prohibited by Instruction No. 6 on the cover of A.B.4. The use of a red ink fountain pen, recommended on page 31, is, therefore, not permissible.

R.M.H.L.

RECOVERY.

THE SECOND EFFORT.

By SIR ARTHUR SALTER, K.C.B.

(Bell & Sons. 10s. 6d. net.)

Perhaps nowhere can the general world situation be viewed to better advantage than from the Secretariat of the League of Nations. Opportunities are to be had there which no other position can provide. The author of this book has been head of the Financial and Economic Section of the League since 1919, and before that, Secretary of the Reparations Commission. He is, therefore, probably better equipped than any living person to make a survey of the world's economic position and to suggest remedies for the present intolerable situation.

He has produced a volume in which is set forth, in as simple language as so complicated and intricate a subject admits of, a brilliant summary of the various causes, economic and political, which have contributed to the world crisis.

In his search for the reasons of our present distresses the author says: "It is not "one of destruction, or of failure in production or in resources, but of dislocation. If "we had had a system which enabled us to utilize fully our capacity to produce, "without paralysing interruptions, it would have been but a year or two before the "world had not only repaired its war losses, but advanced to a standard of prosperity "never before attained and scarcely imagined."

Owing to the enormous increase in facilities for communication, the world has ceased to be an assemblage of nations in watertight compartments; yet governments

will not recognize that international barriers must be broken down before we can "utilize fully our capacity to produce" which modern invention has placed at our disposal.

The difficulties of arriving at any kind of workable system are enormous; but he thinks "difficult as it may be, the problem facing us is capable of human solution." What is required is true co-operation between nations. To bring this about in any real sense is a Herculean task, to which there seem to be almost insuperable barriers in the way.

Of two economic arrangements, a self-regulating automatic system depending on supply and demand, and a system under which the requirements of the community are estimated in advance and production regulated accordingly; the former gives great stimulus to productive capacity and responds easily to the requirements of the consumer, but involves waste when demand is irregular; in the latter system, a weaker stimulus is given to production, but it tends to a more equable distribution of supplies. At present we occupy an intermediate position between the two systems, whereby we lose "many of the advantages of both and fail to obtain the full benefits "of either."

The greater part of the book is concerned in discussing these matters and with proposals to remedy them.

Impoverishment in the face of plenty means that the vast system standing between the producer and consumer has developed grave defects. Ability to produce is unable to translate itself into ability to purchase.

Among the various factors that affect and complicate these questions are:—the world's monetary system; reparations and war debts; tariffs; distrust among nations; defective treaties; and not least, American aloofness.

There are two ways in which a stable currency may be maintained—by the use of a rare metal, such as gold, which must be forthcoming in such quantities as to correspond with the demand for it. The other is to issue notes in such a way as to maintain a stable value in relation to commodities, keeping the ratio between supply and demand constant, otherwise a managed currency.

He recommends the creation of conditions under which the gold standard will work satisfactorily, and the return to gold, at appropriate parities, of countries now off it.

Much of our trouble is due to bad lending. The establishment of a central authority is advocated under the League of Nations, to control the borrowing of governments, to lay down principles upon which loans should be arranged and to examine all proposals in their economic and political aspects.

This would require very close co-operation between nations.

Reparations and war debts and their effect on the situation are fully and clearly explained, especially the American debt.

In considering the latter there is a point often overlooked. America was interested in the war a considerable time before she became a belligerent and even after her entry she was unable to take an active part for nearly a year for want of preparation. But during these periods she did contribute money. Is it not fair to assume that these contributions, which were really a substitute for the supply of men as yet untrained, should be considered as part of America's own war expenditure and not as a debt to the Allies in the ordinary sense?

Speaking of excessive tariffs now imposed by many countries, the author says: "We are now in sight of the final development of this process in a practically com-"plete stoppage of all international trade, except in such articles as cannot be either "dispensed with or produced at home." He adds, the losses incurred may "create "conditions favourable to a new effort to reform commercial policy." The author seems, on the whole, to take a moderate Liberal politician's view of tariff questions.

The United States of Europe proposal of M. Briand, one of the chief economic objects of which would be to form a Zollverein with a common tariff, is discussed and the great difficulties in the way of such a proposal are pointed out.

Two chapters are devoted to treaty-making during the last ten years and to the

Covenant and Kellogg Pact. "The framework is there, but the building is incomplete "and the foundations themselves are insecure." Every agreement into which European countries may enter is completely undermined by uncertainty as to the attitude of America. There are, however, some signs that she will relax the rigid attitude she has taken up in the past.

The author is an ardent admirer of President Wilson, in whose praise he writes in almost extravagant language, as the originator of the League of Nations. But he was disowned on his return to Washington, largely through his own initial mistakes —the Treaty was never ratified—hence most of the trouble since. Probably history will record many divergent views on Wilson.

There is an excellent sketch of the present position of Europe and the interactions, both political and economic, that are taking place—this, in the clear language of the writer, is most informative: Great Britain has been by far the most generous of those who have participated in treaties and agreements since the war.

In the Balfour Note and the guaranteeing of the Franco-German frontier it is felt that we have assumed disproportionate burdens in return for which we have derived no national advantage beyond the *hope* of making the way to peace easier.

The fact is, sad to relate, international generosity is usually misplaced generosity.

We cannot speak too highly of this book as the clearest exposition which has yet appeared on the subject of the world crisis and its causes. To study it is an education in itself.

It is not possible in a short review to do justice to this work, which must be read and re-read to be appreciated.

H.L.C.

BELATED COMMENTS ON A GREAT EVENT.

By MAJOR-GENERAL H. ROWAN ROBINSON, C.M.G., D.S.O., *p.s.c.*

(Williams & Norgate, Ltd. London, 1932. Price, 4s. 6d.)

The "Great Event" is the battle of St. Quentin, in March, 1918. The "Comments" were written before the appearance of General Gough's "Fifth Army," but the author tells us that he had read extracts from the latter before his own book left the printer's hands; the only criticism he has to make on it is that General Gough's readers may disagree with him in his claim to have brought his operations in March, 1918, to a successful conclusion.

General Rowan Robinson, now retired and holding the appointment of Inspector-General of the Iraq military forces, lays stress on the fact that his "Belated Comments" have for their object "neither vindication nor reproach, but merely the "investigation of the causes of the greatest defeat the British Army has ever suffered." He claims to show that the blame for the disaster must be widely shared, and that the portion to be directly attributed to the Commander of the Fifth Army and his troops is small compared to the services they rendered to the country in the unequal struggle.

One of the results of his investigation is that he thinks that the British public was somehow led to believe that the army was nowhere at fault: that the troops fought magnificently and were skilfully commanded; and that it was only luck that was against the British arms in March, 1918. This general belief he stamps as a myth, and infers that the nation only got what it deserved, a sound thrashing for all its shortcomings in the art and conduct of war.

To justify his conclusion he has to find another scapegoat, other than what he terms the usual political victim, in this case the Commander of the Fifth Army. He fixes on the British Commander-in-Chief, or alternatively the Operations Sections of the General Staff at G.H.Q. in France. In the end he relents as far as the C.-in-C. is concerned, and concludes his study with a panegyric on the outstanding character and qualities of the great Field Marshal who led the British Army to final victory.

The author does no more than justice in giving full credit to German brains, thoroughness and forethought in concentrating a superior force at the vital point on the Western Front, and he pays tribute to the willpower and genius of General Ludendorf for the way in which he trained his troops for open warfare and staged his attack for the final bid for penetration. "Ludendorf," he writes, "has been much criti-" cized for having placed tactics before strategy in his plan: and, certainly, greater " strategic results were probable if penetration could have been effected in the northern " zone of the British front. But in penetration lay the rub. It has always been a com-" mon-place of the military art that tactics must set the seal on strategy. But, in posi-" tion warfare, the situation is reversed. Unless the burglar can first prise open the " safe he cannot even reach, much less exploit, the treasure within. The success of " the assailants against the Fifth Army and their failure against the First Army " and the left of the Third Army, whose positions were more heavily entrenched and " more strongly manned, indicate the soundness of Ludendorf's judgment in this " matter." May it not be added that the German failure to prise open the safe is equally a tribute to the soundness of Sir Douglas Haig's judgment in defence?

General Rowan Robinson's little book, of only 112 pages (without maps or an index), is well worth reading by those who may have to study the campaign, for the author brings out his points in simple and definite style. Its appearance contemporaneously almost with General Gough's reminiscences was timely. They should be read in conjunction with each other and will provide food for thought, even to the Official Historian.

H.B-W.

BOXING.

A Guide to Modern Methods by VISCOUNT KNEBWORTH, with a contribution by W. CHILDS, Coach to the Cambridge University Boxing Club.

(The Lonsdale Library, Volume XI.)

(Illustrations. Qt. Leather, 25s. Buckram, 12s. 6d.)

The Lonsdale Library of Sports, Games and Pastimes supplies a very long-felt need, giving as it does to the public up-to-date and exhaustive information; but what especially commends it is the fact that each subject is dealt with by an authority. The books themselves, so easy to read, and generously illustrated, make a welcome addition to any library, and this one is well up to standard. The author has dealt with his subject in such a way that one's interest is held and stimulated from cover to cover.

The early chapters, mainly of historical character, which give a brief account of the birth of boxing, and its growth through the days of the prize ring and Queensberry Ring up to the present day, are so full of quaint and amusing anecdotes that they make excellent reading.

In dealing with the art and science of boxing, his teaching is so clear, with its many illustrations, that the author leaves us in no doubt as to the value of his work both for beginners and more seasoned boxers.

Fortunate, indeed, are we to have a chapter by Mr. W. Childs on "General Hints to Beginners and Instructors." For those of us who have been lucky enough to toil under his all-seeing eye know something of his worth as an instructor and also as a boxer. The chapters on training and seconding are of real value.

We see from time to time so many promising bouts curtailed through insufficient training, and it is refreshing to have such a clear-cut analysis put before us.

The chapter, too, on refereeing and judging gives all budding referees and judges good, much-needed advice, and is full of sound commonsense.

It is altogether a great work, on which the author is to be congratulated. True, the price may deter some would-be purchasers, but where possible I am certain a copy should be obtained, and all interested in boxing should be encouraged to read it.

S.J.S.

THE MODERN DOWSER.

By LE VICOMTE HENRY DE FRANCE.

(Translated by A. H. BELL.)

(G. Bell & Sons, Ltd. Price, 3s. 6d.)

The practice of water divining is yearly becoming less regarded as a form of witchcraft.

In France, notably, the scientific aspect has been the subject of much study and many remarkable results have been obtained.

The cover of this book states that the Dowser need not be a specially gifted person, but that anyone who cares to can attain to a mastery of the principles of dowsing, and an ability to make practical use of them.

This has not been my own experience but, at the same time, there are undoubtedly many persons, at present unaware of the fact, who would experience a strong reaction should they experiment with dowsing.

The Modern Dowser is a practical guide to divining and by following the instructions and advice given therein, a marked reaction to the divining rod or pendulum would soon be discovered.

The earlier chapters give a brief history of divining and an explanation of the movement of the rod and pendulum.

The explanation is weak, in that it propounds a theory, and proceeds to confirm it by unsatisfactory experiment.

Up to the present, however, no satisfactory explanation of the movement of the divining rod has been given by any writer.

The experiments which are explained are, for the most part, simple and easy to follow, and would be of value to convince a person of his own powers of dowsing.

It is interesting to note that the author stresses the importance of a knowledge of geology to the dowser. When seeking water it is useless, as he says, to look for water where geology tells us there cannot be any.

Many methods of detecting the presence of water and dealing with depth, quantity and analysis are given.

The student may discover that he is unable to obtain all the reactions and results outlined. In my opinion, this does not matter. He should concentrate on developing the reactions which are marked and base further progression on experience.

When writing on such a controversial subject as Water Divining, the noble author might have avoided saying that, " The best of all drinks is good water " !

The book next goes on to deal with the method of divining by means of samples, thus extending the field of discovery to almost any hidden object, and even ventures into the realm of biology.

To sum up, here is a useful primer on divining which should establish confidence in one who finds he is capable of dowsing.

Although there are only a hundred and thirty pages of large print, the reader should be warned that a wide ground is covered, and should he carry out the experiments outlined therein, he must avoid a temptation to rush them.

Water supply is becoming an increasingly difficult problem for future warfare owing to the vastness of numbers.

Should a campaign occur in the dry wastes of the Middle East or Central Asia the possibility of tapping underground supplies of water would become of the greatest importance.

Distribution of water to an army in the field is the work of the Royal Engineers, eventually discovery of underground sources may well be added to these duties.

A.J.E.

LUBRICATING OIL TESTS AND THEIR SIGNIFICANCE.

By J. E. Southcombe, M.Sc.

(The Henry Wells Oil Co., Ltd., 736–739, Salisbury House, London, E.C.2. Price, 2s. 6d. 69 pp.)

Mr. Southcombe is a director of the Henry Wells Oil Company, and he writes with the authority of long experience. In this work he has succeeded in giving a very clear exposition of the principles of lubrication, the various characteristics of lubricants, and the tests which are necessary to determine the real efficiency of any lubricant in practice. His language throughout is of the simplest and he has avoided "the jargon of the chemist and engineer" as far as possible.

The book contains many excellent diagrams and illustrations of testing apparatus.

The Henry Wells Oil Company has made a special study of the "Oiliness" of oils and has devised a new "Oiliness" testing machine. The capacity of some of the higher fatty acids to increase "Oiliness," when added in very small percentages to mineral oils, has been made use of by the Company in producing what are termed "Germ Oils." The "Germ," which is the fatty acid content of the oil, anchors itself to the metal-bearing surfaces and very remarkable test figures are quoted to show the consequent reduction in the coefficient of friction. This effect is particularly evident under conditions of "Boundary" lubrication, but recent tests have also shown improvement at comparatively high speeds.

Various factors leading to the contamination and deterioration of oil during use are discussed in a series of short notes. The author also deals with the reclamation of used oils and finally includes some highly instructive remarks on oil specifications.

Mr. Southcombe may be congratulated on covering so much ground in so short a book. His purpose in writing it has been to help the engineer, the oil user and the oil salesman, but his work is also invaluable as a short introduction to a difficult subject and as a reference for any lecturer who may have to touch upon lubrication in the course of a more general syllabus.

S.G.G.

THE THEORY AND DESIGN OF STRUCTURES.

By Ewart S. Andrews.

(Chapman & Hall. 13s. 6d.)

The first edition of this work appeared in 1908, the fourth in 1915. Since then there have been four reprints in which additions appeared in the form of appendices. The fifth edition, which is now under review, has been revised throughout and many of the chapters have been largely rewritten.

As indicated in the title, the book deals with two distinct though interdependent subjects, the first fourteen chapters being devoted to the theory, and the remaining four to the design of structures.

Apart from a few printing errors in the earlier chapters (notably several on page 269 which mar an interesting and concise introduction to the method of "Characteristic Points"), the main criticisms must be directed against the portion devoted to design. This is unfortunately overcondensed and insufficiently cross-referenced to the corresponding Theory section, the latter defect being emphasized by an inadequate index. Chapter XV, devoted to Reinforced Concrete and Similar Structures needs considerable amplification if it is to attain to the high standard set by the earlier part of the book; while the section in Chapter XVI, dealing with Fireproof Construction, would be enhanced in value by the inclusion of some indication of the methods of calculating the floors illustrated.

If the recent report of the Commission on Steel Structures is universally adopted, it will be necessary to introduce a number of modifications into future editions.

The diagrams are clear, but improvements could be effected in the lettering and insertion.

A.J.C.

MATHEMATICS—A TEXT-BOOK FOR TECHNICAL STUDENTS.

By B. B. Low.

(Longmans. Price, 12s. 6d.)

The author, who is a lecturer in mechanical engineering at the Royal Military College of Science, is to be congratulated on having produced a work which is at once both clear and complete, and of which the arrangement is refreshingly sensible.

In it he has summarized all the essential mathematics required by an Engineering student, and the result is a book which will be invaluable to young officers revising their work for the Cambridge Qualifying Examination.

The book may be divided roughly into two parts: the first half recapitulates in a concise manner the algebra and trigonometry that is constantly required—the sections dealing with partial fractions and the binomial theorem are as clear as their importance warrants, while the chapter on "The determination of Empirical Laws" is admirable.

The remaining half of the book is on calculus, and is treated more fully. The differential calculus is dealt with on first principles and its applications are fully explained in some very lucid examples on the rotating vector conception of S.H.M., maxima and minima, and on small corrections and approximations.

Integral calculus is introduced by a variety of practical examples of integration from first principles such as the determination of areas under curves, volumes of solids of revolution, areas of surfaces of revolution, Pappus' theorems, centres of gravity and moments of inertia.

These examples of "applications" whet the appetite for the heavier chapter on "Methods of Integration" which follows. This chapter is probably the most important in the book, and the methods are well illustrated by examples—"integration by parts" is dealt with by the method of substitution, and one would have liked to be shown as well the method of transposition which to many individuals is clearer.

This brings us to the end of Chapter XVIII and we find that the schedule of the Cambridge Qualifying Examination has been handsomely covered, except possibly for analytical geometry, the chapter on which is rather thin.

R.E. officers will find the remainder of the book, including an earlier chapter on partial differentiation, of direct value during the Cambridge course, in particular the chapters on complex quantities, harmonic analysis, and the solution of differential equations.

The only criticism one can offer is that there is no treatment of undetermined forms, such as $\frac{0}{0}$, and the heaviside and vector methods of determining particular integrals are not given.

This is a book which can be strongly recommended to R.E. officers coming to Cambridge, and its adoption at the R.M.A. as a standard text-book for advanced students would benefit those cadets who aspire to a commission in the corps.

R.S.R.K.

CENTRAL HEATING AND HOT WATER SUPPLY FOR PRIVATE HOUSES.

By G. C. SANDFORD, A.M.I.M.E.

(Publishers: Crosby Lockwood & Son, Stationers' Hall Court, Ludgate Hill, London, E.C.4. Price, 8s. 6d. net.)

In his preface the author points out that he "has been struck with the number "of inefficient Heating and Hot Water Supply Systems installed, particularly with "regard to Hot Water Supplies, and the lack of practical literature on the subject," and gives this as his reason for writing the book.

The first part of his statement is true, but I think it is due more to the fact that

engineers dealing with the installation of hot water systems do not take the trouble to read the many excellent treatises on both the practical and the theoretical side of the subject, than to the lack of readable literature on the subject.

Some of the recommendations made by the author are definitely unsound from a practical point of view as will be shown later; and where he has dipped into theory, which is really very simple to anyone who has studied the behaviour of water when heated, he makes such heavy weather of it and gets so tied up in words, that he makes it look much more difficult than it really is.

In order to justify the above statement it will be necessary to deal with these recommendations, etc., and show how they are unsound.

In doing so several important points in design of systems which are often missed by engineers, but which are stressed by the author, will be mentioned.

Part I.—Heating with Low-pressure Hot Water.

Chapter I.—Shows the importance of getting rid of air liberated when water is heated and explains how this is done.

The fact that air is liberated when water is heated and can cause the complete breakdown of any system is not fully realized in the Service.

The results given by the formula in *Chapter III* for the quantity of heat required are low compared with those given by the formula in the W.D. Notes on Heating for a 9-inch wall which gives satisfactory figures.

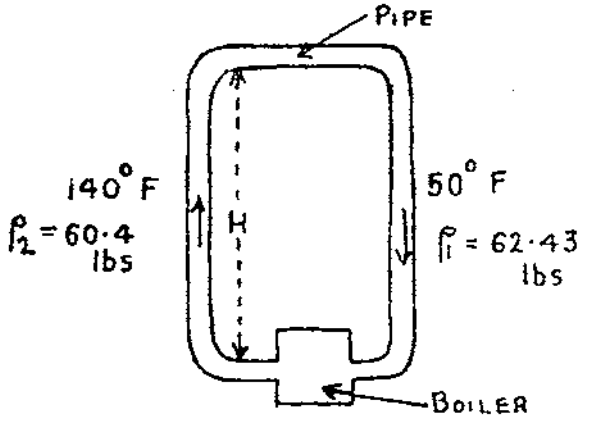
The explanation in *Chapter IV* of how water expands when heated is very cumbersome and could have been made clear very much more simply.

Chapter V deals with circulating pressure and is so involved that it is extremely difficult to understand how the author arrives at the circulating pressure or head.

A paragraph would give all the information necessary and explain how circulating head is calculated thus:—

> "Chapter IV shows that the travel of hot water is caused by the difference in density per foot head between the hot and cold streams.
>
> The circulating head is, therefore, dependent on this difference.
>
> Bernouilli, a scientist, has proved by experiment that

$$\text{Head } (h) = \frac{\text{Pressure } (p)}{\text{Density } (\rho)}.$$



Referring to the diagram:

The 'p' in the descending Cold Column = H × ρ_1, and 'p' in the ascending Hot Column = H × ρ_2.

$\therefore$ the difference or circulating pressure $(Cp) = H\ (\rho_1 - \rho_2)$,
and the circulating head (h)

$$= \frac{Cp}{\text{Mean } \rho} = \frac{H\ (\rho_1 - \rho_2)}{\frac{1}{2}\ (\rho_1 + \rho_2)} \text{ feet,}$$

$$= \frac{12H\ (\rho_1 - \rho_2)}{\frac{1}{2}\ (\rho_1 + \rho_2)} \text{ inches."}$$

Chapter VI points out the necessity for allowing for the extra resistance to the flow due to bends and elbows in the pipes.

This is a point which is often forgotten and if not allowed for may make just the difference between a good and a bad system.

Chapter VII.—The suggestion that if the safety valve cannot be fitted to the boiler it should be fixed on the primary flow is not sound.

In hard water districts particularly, most of the scale is deposited in the primary flow pipe and if the safety valve is fitted thereto there is a grave danger of the pipe leading to it being blocked. On the other hand, if the safety valve is fitted to the primary return near the boiler it will serve its purpose and will not get blocked.

On page 29 it is suggested that the house servants should regulate the boiler fire with the aid of a thermometer!

It is hard enough to get the modern servant to stoke the boiler fire at all, and they certainly could not be persuaded to regulate their stoking by thermometer readings!

The figures given in *Chapter IX* of fuel consumption are very useful.

Chapter X, page 40.—The temperature of the return should be 140°F. 160°F. is the mean temperature of the flow and return.

Chapter XI could well be omitted as it merely summarizes the information already given.

Para. 1 of *Chapter XII* is very confusing. It is intended to convey the fact that the flow pipe decreases in size as it passes the work, whereas the return pipe increases in size as it collects its cooled water.

In discussing the disadvantages of a system with a straight vertical flow from the boiler it should be explained how the "individual circulation" can be prevented, viz., by fitting regulating valves with lock shields which should be set when the system is tried out.

Chapter XIV deals with one-pipe ring main system and stresses the importance of taking the flow branch pipe to radiators out of the top of the main and returning the used water into the side.

This is a point which is often forgotten and makes a great deal of difference to the efficiency of the system.

On page 55 the figures for artificial head are wrong. If "Y" = 8 feet "X" must be considerably more than 12 feet. The result of the calculation, owing to this error, is wrong, but the principle is correct.

The description in *Chapter XIX* of the difficulties of designing a system in which the boiler has to be above the lowest radiators is very well presented and shows how these difficulties can be overcome.

The necessity for an air cock on the left for the door in Room "B" (page 72) is not understood. No air can accumulate there as the pipe is rising.

The importance of easy bends is emphasized.

PART II.—HOT WATER SUPPLY.

Chapter XX explains very clearly how to calculate the quantity of hot water required in a house, but the number of baths per hour, given in *Chapter XXI*, page 82, is too low.

The sizes recommended for primary flow and return pipes are extravagant. One-inch works very well for storage capacities up to 50 gallons and 1½-inch pipe up to 200 gallons.

In this chapter and those following, the author agrees with modern writers on the subject that the primary flow should enter the cylinder near its top, but he brings his secondary return in below it.

The object of the secondary circuit is to deliver the hottest possible water at any tap which may be turned on. Water from the cylinder flows both up the flow and the return pipe directly a tap is opened.

Therefore, if the secondary return draws its water from below the mouth of the primary flow, it will not be drawing the hottest water which, being lighter, must lie above the entry of the primary flow.

Chapter XXVI explains the method of heating domestic hot water by placing small radiators in hot water cylinders.

This method is increasing in popularity every day, especially for the larger houses, such as Group III and upwards, where radiators are now installed to heat the building.

This system would be particularly useful in blocks of officers' quarters, where baths are usually required in the evening.

Connections to towel rails and coils in linen cupboards are usually difficult to make and the author explains very clearly how these connections should be made to give the best results.

Appendix I could well be omitted as it explains the use of decimals. Anyone capable of designing and calculating out a heating system has learnt to use decimals before he left school.

Appendix II gives "Useful Data." This appendix is of real value and gives a tremendous amount of information which one does not usually carry in one's head and which is not easily found in engineering pocket-books.

The tables at the end of the book are good value and help to reduce the amount of "X" chasing necessary in working out heating calculations and in taking out quantities and weights of materials.

A table or graph might be added which shows the decrease in weight of a cubic foot of water at every 5° rise in temperature when heated from, say, 35°F. to 250°F. and every 10° rise between 250°F. and 400°F.

This information is very valuable and is given in very few text-books on water engineering.

From the above it will be seen that the book contains mistakes in the calculations, but these mistakes are so obvious that they probably would not mislead a student reading the book.

On the other hand, the unsound suggestions *re* pipe connections, etc., might lead to a young engineer getting a bad name for designing a faulty system.

Apart from the above-mentioned points the book contains a wealth of information which would be of value to anyone studying the subject, particularly the military clerks of works faced with the design and installation of a heating or hot water supply system.

The book contains a table of contents and a good index. It is also full of very clear sketches and diagrams illustrating the text and giving examples of the various systems explained. B.C.T.F.

THE MANAGEMENT OF NATIONAL SAVINGS CERTIFICATES.

By W. N. Burwell-Bedford, R.E. (retd.).

(Fisher & Sons, Newnham Street, Bedford. 6d. post free.)

This pamphlet is a "hint to surtax-payers and their poor relations," and therefore may be expected to have a limited appeal to the Corps as regards the former class. It shows, however, how a regular annual income may be obtained from National

Savings Certificates by a combined family investment of £3,200 or less, according to the size of the family in question. By following one of the tables given for operations on £800 capital over a period of 10 years, an investor can obtain never less than £31 income tax free on £800 to add to his expendable income, and an average income, for these 10 years, of £32·461. This, with no risk of losing capital or fear of depreciation, should give a comfortable feeling to the comparatively modest investor. Two other tables are given, of a rather more complicated nature, and one to show how not to do it. The whole pamphlet is of great interest to a Briton living in Britain and is well worth the modest 6d. The author writes under a pseudonym.

P.H.K.

BOOKS FOR GENERAL READING.

Recommended by Brig.-General Sir James Edmonds, C.B., C.M.G.

THE STREAM OF TIME (Bodley Head). By Mrs. C. S. Peel.

An interesting study of social and domestic life in England, 1805–1861.

IMPERIAL BROTHER (Philip Allan). By Maristan Chapman.

The life of Le Duc de Morny (died 1865), half-brother of Napoleon III., his inspirer and ill-genius.

ONLY YESTERDAY (Harper). By F. L. Allen.

" An informal history of the nineteen-twenties " in the U.S.A. All the scandals (*e.g.*, Tea Pot Dome) and the decline of social, commercial and political morals, and " ballyhoolying," " rackets," etc., are described. Very illuminating.

THE FORGE (Heinemann). By T. S. Stribling.

A good novel, staged in Alabama, before, during and just after the Civil War of 1861–5.

Recommended by Colonel F. C. Molesworth.

THE LONDON CYCLIST BATTALION (Forster, Groom & Co.).

A very good account of a territorial unit's part in the Waziristan Campaign of 1917, the Amritsar rising of 1919, and the Third Afghan War.

Recommended by Colonel H. L. C. H. Stafford.

PRINCIPLES OF PUBLIC FINANCE (Routledge). By Hugh Dalton.

MAGAZINES.

BULLETIN BELGE DES SCIENCES MILITAIRES.

(1932. TOME I.—NOS. 1 TO 3 INCLUSIVE.)

Les opérations de l'Armée Belge pendant la campagne 1914–1918. Two parts of an article under this main title appear in Nos. 1 and 2. An account of the battle of Merckem (April 17th, 1918) is given in No. 1; this battle constitutes one of the episodes of the German offensive in Flanders which was launched on April 9th, 1918. Two German armies took part in this offensive: the Sixth Army was directed on Hazebrouck and advanced from the part of the front extending southward of Armentières as far as the La Bassée Canal (battle of Armentières); the Fourth Army operated on the front northward of Armentières as far as the Comines Canal, and to it was assigned the task of breaking through the British line with a view to an advance on Poperinghe (battle of Kemmel).

The success of this manœuvre would have placed the Channel ports at the mercy of the Germans, and would further have resulted in the envelopment of the southern part of the section of the Entente front between Armentières and the North Sea, which was held by the British Second Army and the Belgians. Owing to the energetic resistance put up by the British troops and the timely intervention of French reinforcements the enemy's advance was completely checked.

The German plan of attack is examined in No. 1 in considerable detail. Particulars are also given therein of the Belgian dispositions; an account is given of the defensive arrangements south of the Yser and the manner in which the Merckem and Boesinghe zones were occupied. The operations on the section of the front which was occupied by the Belgian 10th and 3rd Divisions are described at some length. This part of the article concludes with a brief summary of the disturbing effect which was produced at the German G.H.Q. by the check met with at Merckem by the Fourth Army.

Events on the Belgian front during the period April 18th—June 6th, 1918, are discussed in No. 2: at this time the Belgian line extended from the North Sea to St. Julien. Foch, who had very recently been charged with the direction of the strategic operations of the Franco-British Front (Beauvais Agreement of April 3rd, 1918), addressed (in view of the serious danger which menaced the Entente forces owing to the German advance on Hazebrouck) a memo to the Belgian High Command on April 12th, suggesting that Belgian troops—two infantry and two cavalry divisions—should be placed at Plumer's disposal. The Belgian C.G.S., in his reply to Foch, stated that a move of the Belgian Reserves southwards would weaken the left wing of the Entente forces covering the Channel ports, and reiterated the view, which occurs from time to time in communications from the Belgian High Command: "The Constitution forbids us to place portions of the Belgian Army under the orders of foreign commanders."

On April 13th, Col. Desticker was sent by Foch to the Belgian G.H.Q. further to discuss the matter. The Belgian High Command was obdurate on the question of placing Belgian troops under the orders of a foreign commander, but agreed, on the other hand, to an immediate extension of the Belgian front southwards. Eventually Foch personally visited the Belgian G.H.Q., and it was arranged that the Belgian Army should take over about three km. of front west of St. Julien.

An account is given in No. 2 of the arrangements made for co-ordinating the

operations of the Entente troops in Flanders: the text of certain important communications bearing on the subject are reproduced. Particulars are also given of the final conference which was summoned by Foch to discuss the subject; it was held at Blendecques and attended by staff officers representing Foch, Haig, King Albert, Plumer and the Commander of the Detachment of the French Northern Army. The views expressed by the several staff officers present were embodied in a memo, the text of which appears in the original article.

The dispositions made to meet the German offensive are set out in No. 2, and the text of the instructions issued by the Belgian G.S. in relation to the measures to be adopted in the event of an attack and the employment of the Reserves in the Merckem and Boesinghe zones are also reproduced. The Belgian system of defences is described and an account is given of the minor operations on the Belgian front.

Pages d'histoire de l'Armée Belge au cours de la guerre 1914–1918. Articles with distinctive sub-titles appear under this main title in Nos. 1 and 3. The article in No. 1 bears the sub-title *Un épisode de l'historique du 1er Carabiniers. Drie Grachten (avril* 1915), and is contributed by Major Bouha. In March, 1915, the Belgian main position passed through Noorschoot; westward of this village was situated the very exposed advanced post at Drie Grachten, the defence works of which were being continually destroyed by the enemy. Small bodies of the 1er Carabiniers, however, tenaciously held on to this advanced position, and in spite of the nearness of the enemy managed for a considerable time to repair the damage done to the defences of the post. Eventually, on April 8th, 1915, the Belgian works at this point were completely destroyed by the German artillery and the small garrison in the works was, at the same time, wiped out. An account is given in No. 1 of the struggle which took place for the possession of the post at Drie Grachten, and of the heroism of the men of the 1er Carabiniers to whom was entrusted the defence of the post.

The article in No. 3 bears the sub-title *Les Combats d'Ussoke et Mabama* and is contributed by Capt. Weber; it deals with an episode in the Tabora Campaign (1916), in which African soldiers under General Tombeur played a conspicuous part.

La Bataille de Kemmel (avril 1918). The three parts of this article appear successively in the numbers of the *Bulletin* under notice; Capt. Dereur, of the French Army —he took part in the battle with the French 28th Division—and Lieut. Scius have collaborated with Lieut.-Col. van Overstraten in the preparation of the articles.

The battle of Kemmel marks the final crisis of the German offensive in the spring of 1918. On March 28th, 1918, Ludendorff had given instructions for an attack to be launched in the direction of Hazebrouck. In consequence, a final effort was made by the Germans on April 4th to break through the British front south of the Somme; it produced only insignificant results. The Germans were held up before Arras and Montdidier; the route to Amiens was still blocked; and the junction between the British and French forces was firmly established. Accordingly, the Q.M.G. turned his attention impatiently to the situation in Flanders, where he hoped to obtain a decisive victory. The moment and the locality were favourable for the enterprise. A dry spring had caused the ground in the Lys valley to become firm earlier than was usually the case; the wastage in the British Army had been very considerable (out of 58 divisions on the French front, 46 had already suffered heavy losses during the spring battles); on the Lys, the Australian Corps had been replaced by "tired" divisions. The front chosen by Ludendorff for the attack included the sector held by the Portuguese.

The situation on the British front as it existed in the early days of April is sketched in No. 1. A part of the French Tenth Army had been moved into the British zone west of Amiens, and at this time constituted a Reserve under Gen. Maistre.

An attack, preceded by a three hours' artillery bombardment—gas shell being largely used—was launched on April 9th by eight divisions of the German Sixth Army on the 15-km. section of the line between La Bassée and Armentières; the enemy broke through the Portuguese front.

The measures taken to stem the German advance, and the events comprised in the period April 9th/25th are described in No. 1. On April 10th, the German High Command seems to have come to the conclusion that the offensive was already doomed to failure; on that day, on the representations of von Lossberg, C. of S. of the German Fourth Army, Ludendorff decided that the attack against Bixschoote and Poperinghe should be abandoned.

The events of April 25th and 26th are described in No. 2. The Kaiser had arrived at the H.Q. of the German Fourth Army on April 20th, and at 10.30 on that day orders were issued to this Army for the attack against Kemmel; the date for the attack was fixed for the 25th. The XVIII. and X. Corps were detailed for the task; extracts from the Orders issued to these Corps are published in No. 2, and the progress of the battle is described therein.

The events of April 29th are dealt with in No. 3. The day opened with a violent bombardment by the German artillery; the German Air Force was also particularly active. The Entente artillery, which had reserved its fire during the preparatory stage, took up the challenge as soon as the enemy infantry began to advance, and put up a formidable and effective barrage. The German High Command was taken completely by surprise on finding that the Entente artillery was in position in the Vlamertinghe and Reninghelst valley. The German attack failed; orders were accordingly issued at 10.30 p.m. on April 29th that the attack of the German Fourth Army should not be resumed on the following day.

Un quartier général de division d'infanterie à l'œuvre pour une prise de position au cours d'un débarquement de chemin de fer. This article is contributed to No. 1 by Lieut.-Col. Derousseaux; it contains a strategical exercise and its solution. The General Idea states that a Red Army (North) and a Blue Army (South) are facing one another on the line Mons–Fleurus–Namur–Luxemburg, after an indecisive battle. The Commander of the Red Army learns that Blue reinforcements are detraining at Maubeuge, Bavais and Valenciennes: he decides to reinforce his western wing by three Corps which are to be moved by rail from the east *via* Aix-la-Chapelle to the region between the Dendre and the Senne, where it will constitute a new First Army. The arrangements for the transport of this new army are given in detail.

The Special Idea describes the dispositions of the Red Army, and states that the Commander of the 1st Division (First Army) on arrival at Enghien is handed an "Operation Order," the text of which is set out in the original article: he is directed therein to take up a position to cover the detrainment of the First Army. The various measures which should be adopted by the recipient of the said Order are discussed, and extracts are given from the Orders assumed to have been issued by him.

Les Acropoles ou la Fortification permanente dans l'Antiquité. The third and final parts of this article by Major Delvaux are published in Nos. 1 and 3 respectively. The subject of the attack and defence of fortresses in ancient times is dealt with in No. 1, wherein a description is given of the siege *matériel* then in use. The siege of Platæa, and the first and second sieges of Syracuse are also dealt with therein.

The sieges of Tyre (332 B.C.), Agrigentum (261 B.C.), Lilybæum (251–241 B.C.) and Carthage (146 B.C.) are dealt with in No. 3; Egyptian, Assyrian, Babylonian and Persian fortifications are also discussed in this number.

L'homme du destin. This article is contributed to No. 2 by Lieut.-Col. van Overstraten, who briefly reviews therein the outstanding qualities of Foch.

Conférence générale de limitation et de réduction des armements. This article is anonymously contributed to No. 2; it contains comments on Major Diependrijkx's articles entitled *La Trêve des Armements*, published in the numbers of the *Bulletin* for November, 1930, and May, 1931; the text of the French Memorandum; a *résumé* of the British Memorandum; and a table setting out the principal features of the armies of various countries.

Ce qu'il faut connaître de l'Artillerie. This article is anonymously contributed to No. 3. General Brossé, of the French Army, in a work entitled *La combinaison des*

armes, points out that on a modern battlefield the several arms are not distinctive forces, each fighting on its own independent account, but are parts of a comprehensive whole, acting in intimate support of one another in order that their united efforts may produce effective results. The Editors of the *Bulletin* consider that some general information relating to the artillery arm and its equipment may prove useful and helpful to officers belonging to all arms of the service, and have accordingly had this article prepared for the *Bulletin*; information is given therein which should particularly aid in promoting the closest co-operation between the infantry and the artillery.

W.A.J.O'M.

THE MILITARY ENGINEER.

(*January—February*, 1932.)—That disarmament is no safeguard of peace is the argument of the editorial article, *In Defence of Defence*. Man's oldest occupation is that of soldier. The story of mankind has been written by the soldier with his sword, and not by the pedant with his pen. Christianity was borne over the earth on the wings of war. No religion is dominant except in the region where it arose or into which it was carried by arms. Have improvements in arms meant greater suffering? Flesh pierced by a bullet often heals; bones crushed by a primitive axe rarely knit. Is modern war more bloody? In proportion to the numbers engaged the battle of Cannæ, fought with the simple weapons of Rome and Carthage, is not rivalled in slaughter by any battle of the World War. Thermopylæ still stands as the sole recorded instance in which every soldier of an army fell in battle. Does the possession of armament incite to war? Armament is the son of dissension, not its sire. War is bred in the mind of man, not in the blade of his sword. It was not the armaments of the European nations which brought on the World War; it was the jealousies, rivalries and enmities among them. In the perpetual struggle for self-preservation in which all life is engaged absolutely vital conflicts between national interests have constantly arisen and must continue to arise. The peaceful settlement of such conflicts cannot be effected through arbitration agreements. In fact, it can never be effected, for it can come only through mutual understanding and toleration, accompanied by a sacrifice of essential interests which no people can willingly make. The great armaments of the world, the French Army and British Navy, are the agencies which are keeping some semblance of order in European affairs. Wipe them out or radically reduce them and Europe will lie prostrate before the numerically preponderant disciples of discontent.

There are four articles dealing with survey. *An Unusual Problem in Surveying* is an account of establishing astronomically points at intervals on a long theoretical geodetic line through unexplored territory. As the line in question did not form a part of a parallel of latitude nor of a meridian of longitude, the problem became mathematically complex, requiring for its solution the application of advanced geodesy as well as the science of astronomy. The unsurveyed section of the provisional boundary between Ontario and Manitoba, from Island Lake to Hudson Bay, was defined as a straight line joining the east end of the lake to the point where the 89th meridian intersects the south-west coast of Hudson Bay. The latitude of the latter terminal point was as yet unknown. The method adopted is described in full, and there are interesting comments on the use of aeroplanes for reconnaissance, etc.

A detailed description is given of a *New Theodolite for Primary Triangulation*, whose features are ease and rapidity of operation, lightness, and a high degree of accuracy. *Mapping the Hawaiian Islands* is partly historical and partly an account of the work that is now being done. Intricate topography, high brush, inaccessibility and the difficulty of identifying points in station work all show the value of aerial photographic methods. The photographs seem to have been single lens, not stereoscopic.

Holland has a density of population of 600 to the square mile. Her colonies are unsuitable for absorbing a large white population. Expansion by armed force is out

of the question, even if there were any relatively vacant land nearby. The result is the *Zuyder Zee Reclamation Project*, in which is contemplated the eventual reclamation of some 560,000 acres from the Zuyder Zee, and the conversion of the remainder of that salt-water bay into a freshwater lake, with various direct and incidental benefits to the nation. It consists of two main schemes, the leveeing, draining and reclaiming of four large areas, called polders, and the building of a dyke across the mouth of the Zee. A small experimental polder was first made to ensure that the soil would be suitable for crops. The plan of the Government is to prepare the land for occupation in every possible way before inviting settlers. In addition to the major works (dykes, canals, pumping stations and locks) all fields will be completely drained; roads will be built; sites for future villages will be selected; water and electricity will be installed; and certain key buildings will be put up, about 400 in all, including churches, schools, etc., to serve as nuclei. So now the island of Wieringen, one of the oldest parts of Holland, whose history goes back into the heart of the Dark Ages, is to be part of the mainland; in a few years another 90 square miles of sea-floor will be covered with tulips, cabbages, cattle and brick houses.

Slow sand filtration plants are not successful in the Middle West, where the streams are muddy, as the filters soon become clogged. Coagulation is imperative, and it is found to be worth ensuring a very thorough mixing of the coagulant with the water to be treated. Experiments at Chicago show that 30 minutes' mixing is desirable and results in the economical use of the coagulant. The length of the sedimentation period will vary with the character of the water, but three hours is a minimum, six to eight hours is generally desirable, and longer periods are sometimes warranted. (*Water Purification in the Middle West.*)

I.S.O.P.

MILITAERWISSENSCHAFTLICHE MITTEILUNGEN.

(*January–February*, 1932.)—Having regard to the Disarmament Conference, which was about to open at Geneva, on February 2nd, this number appears labelled as a "Disarmament" number, and is entirely devoted to that subject. Colonel Wiktorin leads off with *The Sorrowful Tale of Disarmament*, to which he prefixes the sad motto, "Do as I say, but not as I do." The application of the latter appears to lie in the covering note to the International Treaty of Versailles, in which the French President at that time, M. Clémenceau, said, "The German disarmament represents at the same time the first step towards a general decrease and limitation of armaments, which the allied and associated powers desire to introduce as one of the best means for the prevention of war, and to introduce which is one of the first tasks of the League of Nations. After Germany has shown the way, the allied and associated powers will in full security tread the same path."

In the light of all that has happened since, this was an unfortunate utterance. The author says, "The monstrosity of the terms imposed upon Germany by the Peace Treaty lies not so much in the conditions themselves, as in the hypocritical reason given for their imposition." It is only too easy to understand that circumstances have thus been created which cannot be permanently borne, and which, instead of promoting the reconciliation of nations often announced in such beautiful words, has collected a mass of material for conflict, which sooner or later must lead to an eruption of force. Certainly there have been efforts to further the question of disarmament, but hitherto the opponents of disarmament have always succeeded in hindering any real progress. Colonel Wiktorin recapitulates shortly the story of these efforts and considers he is justified in calling it a sorrowful tale.

Potentiel de guerre, by Colonel Paschek. This phrase, or rather catchword, dates from a certain Geneva questionnaire of December, 1925, and is supposed to mean a nation's whole strength to war, both present and mobilizable, and including, as it must, many sources of power actually not present in peace, and only indirectly

effective as future war means. Question V of the document named laid down that, in order to establish a relationship between the armaments permissible to the various nations, eight different points would have to be specially considered. These were :— (1) population ; (2) resources ; (3) geographical position ; (4) extent and nature of communications by sea ; (5) density and composition of the railway network ; (6) the liability to violation of the frontiers, and the existence of large important centres in their neighbourhood ; (7) the necessary time, varying from state to state, for changing over from peace to war equipments ; (8) the degree of safety which the state may expect in case of an attack, to be gained from the statutes of the League of Nations, or from any special obligations which have been entered into.

From this list, capable, too, of being widely extended, the impossibility is at once apparent of determining with any degree of accuracy any particular nation's *potentiel de guerre*. And yet it is obvious that each nation possesses such a *potentiel de guerre*, and that some of the factors contributing towards it can to some extent be determined—although their comparative valuation must remain a matter of opinion.

The chief trouble with this expression which, after being much quarrelled over, has now come to be loathed, is that it is very difficult to see how the desired international reduction of armaments can ever be legislated for with fairness except when due regard is paid to each nation's (alas ! almost indeterminate) *potentiel de guerre*.

Disarmament and Security. Lieut.-Colonel Rendulic does a very real service in attempting to clear up some of the misunderstandings which have occurred as regards the connection between these two, and which he shows to have been of the League of Nations' own creating.

In December, 1925, and again in May, 1926, the Council of the League of Nations drew up a questionnaire to guide the labours of the Preparatory Commission of the Disarmament Conference. The seventh and last question in this list starts with the words, " Granting that disarmament is dependent upon security. . . ." This idea has played in Geneva ever since a fateful part. It has overhung like a threatening shadow all discussions on disarmament, and is to be found again and again in the speeches of statesmen and politicians : and yet nowhere is a definition of this principle to be found. " Armaments " were defined, " the limitation of armaments " was defined, but no investigation was made as to the meaning of " security."

This was all the more unfortunate because of an early misunderstanding which has never been corrected. It is the express task of the League of Nations to guarantee the security of the members of the League. This is laid down in Appendix 1 of Article 8 of the Statutes, and is completely in accordance with President Wilson's Drafts and with the last of his Fourteen Points. Article 8, however, introduces a contradiction, for it speaks of " a diminution of armaments to the lowest possible extent compatible with national security," thus making national security a matter for each nation to determine for itself instead of leaving its national security entirely to the League of Nations.

It appears now that in President Wilson's draft, with which Appendix 1 of Article 8 agrees almost word for word, the reduction of armaments was to be compatible not with " national " security, but with " internal " security. The alteration which brought about this change occurred at a committee meeting upon the instigation of the Japanese representative. To make disarmament depend not on internal security, but upon national security, is to deprive the League of Nations statute of its real meaning. This idea has been the source of the greatest difficulties with which the disarmament question has had to contend.

The author's conclusions are (1) that as long as armaments exist, which make possible wars of aggression, security based upon international treaties is not to be thought of, and (2) that military armaments also cannot give security. Thus armaments play a dual role : they prevent international security and do not guarantee national security. The explanation of the failure hitherto of all efforts at disarmament is that they have demanded security first.

The Principle of Defence and the Balancing of Armaments. In 1928 six great powers and fifty-three other countries declared in an agreement their condemnation of war as a means for the solution of international disputes, and their renunciation of war for the furtherance of national politics. The natural inalienable fundamental right of nations to self-defence remained unaffected by this agreement. Major Franck here works out the mutual reduction of armaments possible, in personnel and material, if all preparations were confined to defence, and aggressions were entirely ruled out.

The Significance for Universal Disarmament of the Reserves and of Large Stocks of War Material. As regards the latter, Colonel von Oertzen has compiled a comparative table of the peace establishments of fifteen nations and of their war establishments, as far as ascertainable, in machine-guns, field-guns, heavy artillery, tanks and aeroplanes. In the absence of any information about stocks of war material, he has compiled another table of comparative expenditure on defence for 1913, 1927 and 1930, so that we may draw our own conclusions. From this table Great Britain and Japan alone emerge with credit.

In the matter of personnel, another useful table shows yearly numbers of recruits, number of years recallable to the colours, total strength of trained reserves, and percentages in peace and war of soldiers to population. That in gauging armaments peace strengths are unimportant, while the number of trained reserves is all-important, is then brought out by many quotations from British and French statesmen.

The Military Value of Civil Aircraft. Colonel Löhr points a parallel between aircraft and ships. To the universal type of sailing-ship, which could be trader or fighter, or both, there succeeded quite different types of ships for trade and for war, generally incapable of interchanging roles. Similarly, there is already an advanced differentiation in civil aircraft from war types, which is continuing without check. The author makes clear that one cannot truthfully speak in a broad sense of any direct military value appertaining to the civil aeroplane. Against this it cannot be maintained that civil aviation is no sort of support to military flying. Factories of civilian aircraft could turn out military planes quicker than factories which have first to be built. Young civilian pilots can be turned into military pilots quicker than complete beginners. But both of these things take time. To what nation in Europe, he asks, is one going to grant the necessary time in an age not only of independent air warfare, but also of mechanized and motorized armies on the ground ?

The Disarmament of Austria from the Point of View of Weapon Technics. In the large realm of war technics, weapon technics towers in importance above all the other branches of technical art and science, since it is weapon effect which decides the battle. The technics of transport, the technics of communications, and other kinds of applied special sciences have in the end only the one military object, viz., to ensure the effectiveness of weapons at the right time and place. They have to serve weapon technics by suiting themselves to the peculiarities of the individual weapon. In order then to judge, according to their present and future effects, the limitations imposed upon Austria by the Treaty of Versailles, the author, Dr. Leitner, makes a *résumé* of weapons used in land warfare: guns, tanks, armoured cars, flame-throwers, gas. The whole of these are forbidden to Austria by the Peace Treaty except artillery, and that is limited to guns not exceeding 10·5-cm. calibre. Dr. Leitner proves that the calibre limitation was well chosen, and that there is nothing the Austrians can do to improve the performance of their field-gun, so as in any way to counteract the limitation imposed.

As regards tanks, he foresees in the near future raw oil engines, and a wide field of military use for the six-cycle engine; both of which will help the tank to more powerful armament: improved armour and tyres; the application to tanks of naval methods of loading and aiming; progress in the production of artificial smoke, and in smoke-shelling. Hence the battle of the future will be fought on land by tank *v.* tank, like ships at sea.

As regards gas, " the spectre of an unknown gas, which can penetrate all known

means of protection, belongs to the realm of imagination, not that of science." Progressive motorization will diminish the importance of gas, as will also efficient masks and gas measures. The former applies to mustard gas as well as to the battle gases, but not the latter, since protection against mustard gas remains impracticable for wholesale adoption.

Did Armaments Cause the World War? When the title of an article is put in question form, the reader may be pardoned for expecting an answer. In this case he will be disappointed. The nearest that General Schubert gets to answering the question is, " If armaments contributed to the outbreak of the World War, they were certainly not those of the Central Powers, and least of all those of Austro-Hungary." He bases this statement upon facts and figures produced by Major-General Kerchnawe in the next article entitled *The Insufficient War Equipment of the Central Powers*. The same argument has already been used elsewhere (*v. R.E. Journal*, December, 1931, p. 753) as proof positive that Germany in 1914 could not have been thinking of war at all. An inadequate degree of preparedness is, however, unconvincing evidence of design. At the surprising outbreak of the Russo-Japanese War the question, " Were the Russians ready ? " was asked repeatedly in England by many people who wished to explain away the great Japanese success in the harbour of Chemulpo. The answer, " Ready for what they expected, but not for what they got," may be applied to other pleas that innocence can be proved by unpreparedness subsequently discovered.

The remainder of this number continues to deal exhaustively with the subject of disarmament under the headings *War Industry and National Defence, Disarmament in the Air*, by Colonel Löhr, *Disarmament at Sea*, by a naval officer, *Economics and Disarmament, Defence Budgets and Their Camouflage*, and *The Armament Holiday*, by Lieut.-Colonel Regele. The whole is up to the high standard we have been led to expect by " Luftflotten " and the *Mitteilungen's* other special numbers.

(*March–April*, 1932).—*Goethe and Our Soldiers*. When the hundredth anniversary of the death of a great genius like Goethe occurs it is celebrated, and the hero himself is written about in thousands of articles, and from every standpoint. Even a military journal has to join in, and the, in this case, very difficult task was entrusted to Major-General Kerchnawe. Goethe's opinion about war, which he ranks with famine and pestilence, his claim to have nothing warlike in his composition, and his hatred (of which he told Lord Bristol) of those who after committing horrors sing the *Te Deum*, had to be suppressed, and the article almost entirely confines itself to recounting Goethe's pleasant relations with various officers.

A Review of International Military Policy (up to the end of January, 1932). On the grounds of his last similar review being a particularly thorough one, Colonel Paschek reverts from his narrative style, praised by *The R.E. Journal*, December, 1931, to his former chronicle or headline style, which makes jerky reading. A review written in a series of headlines serves best as a reminder to those already acquainted with the events, and is less instructive than an account showing the development of ideas, the relationship of events, and their trend. In these days, when nations in peace can carry on economic warfare, it would perhaps be wiser not to reject offhand Colonel Paschek's reading of the chief event of 1931. " After twelve years of the deepest depression since the conclusion of the great struggle a second world war has literally begun." This is intended not as prophecy, but as fact.

The New British Floating Tank. Lieut.-Colonel Regele writes a short text to accompany twelve photographs of the light Carden Loyd amphibian, for which he thanks the *Illustrated London News* and Vickers-Armstrongs. This amphibian is said to have been built according to the plans of Capt. Liddell Hart. Compared with the first of its kind, the Christie, it weighs 2·8 tons against 7 tons, is 4 metres long against over 5 metres, " steams " 9 to 10 km. an hour against 6 km., climbs 30° (for short distances 45°) against the Christie's 40°. The armament and crew of the Christie were one 37-mm. gun and two to three men. The Carden Loyd has a

machine-gun in a movable turret and a crew of two. It has an indiarubber lining, armoured screw and rudder. Its performance across country or on the roads is that of an ordinary tank. The Christie, built in America as the result of experiments started in 1925, was apparently bought by Japan.

The Light Metals for Army Purposes. The birth of the light metals, by which is generally understood all those metals and metallic alloys of specially low specific weights, took place in 1827, when Wöhler succeeded in separating aluminium by reduction from de-hydrated aluminium chloride. The metal could not, however, be obtained economically until Bunsen, over 20 years later, isolated magnesium electrolytically, and the same method was soon applied successfully to obtaining aluminium. Latterly this pair of metals has been joined by an even lighter one, beryllium. With these three representatives the series is strictly complete, but for the fact that far more important than the pure metals are their alloys. The fame of the light metals rests upon these alloys, of which there is a vast number, and which have been prepared in such proportions and by such treatment as to improve desired qualities and to diminish the effect of the undesired. Ten of the most important of these are named, with their chief properties. They all consist principally of aluminium, with a second metal, of which there is, say, from 4% to 15%, shown in brackets, and very small proportions of from two up to five other metals.

Duralumin (second metal, Cu), very hard and strong; mechanical properties of steel; very ductile; easily worked.
Lautal (Cu), like duralumin.
Silumin (Si), excellent for castings.
Cromal (Cr), as hard as steel; very suitable for castings.
Elektron (Mg), 40% lighter than aluminium; very strong; very dense casting; easy to work, but sensitive to acids.
Magnalium (Mg), hard, ductile, can be forged cold; great resistance to weather.
Constructal (no " second " metal), very strong and ductile.
K.S. Seewasser (Sb), specially resists sea water.
Scleron and Aeron (no " second " metal), bend and roll well.

The light metals have already established themselves in aviation and in mechanical transport. There is no auxiliary branch of the army, especially engineers, signals and supplies where their introduction, which is only a question of time and money, will not by reducing weight increase speed both of movement and of working. If war is movement the light metals which increase mobility have a large part to play in future.

The writer then gives a detailed list with exact weights of all the metal carried by the private soldier. Even leaving out (for the present !) his rifle, bayonet, shrapnel helmet and entrenching tool, there is a saving by using light metals of four and half pounds.

F.A.I.

WEHR UND WAFFEN.

(*January*, 1932.)—*The Bofors 75-mm. Infantry-accompanying Gun M/31*, by Major Mouths. What is understood by an infantry-accompanying gun has been as yet by no means accurately prescribed. This article is noteworthy for two reasons. It starts off with a gallant attempt at definition, and then shows how the latest 1931 model produced by the Swedish firm of Bofors satisfies requirements as regards weight, construction, breaking up into loads, and ballistic performance.

This gun has been produced under the original idea of creating a weapon, which—ballistically a howitzer—with the least weight and the greatest degree of handiness combines the effect of a good mountain-gun with that of a light trench-mortar. At the same time it has to be not only equally mobile, but must be capable of being broken up into mule loads and even, when necessity arises, into man pack, so that it may be capable of accompanying the infantry everywhere, and this irrespective of

whether it is placed permanently under their orders, or only allotted when the occasion demands.

It is thus a gun for direct infantry support in that its object is to make the infantry in the attack capable, without the assistance of the divisional artillery, of destroying nests of heavy machine-guns or of infantry guns, and in the defence capable of taking moving targets, men and horses, under fire, at medium ranges, when they are more or less hidden from sight. Their trajectories must therefore allow of their firing over their own infantry even at very short ranges. Finally the gun must do high-angle fire with trench-mortar bombs, and if it is suitable for anti-tank defence so much the better.

Major Mouths considers that the 75-mm. Bofors infantry gun 1931 model fulfils all these requirements, even to the last, of anti-tank defence; for which, however, it must carry with it a special interchangeable barrel of the same weight but 47-mm. calibre. A table of penetrations then shows that the 47-mm. Bofors with its projectile of 1½ kilos would be, according to de Marre's formula, fatal to medium and light tanks up to over 1,000 metres, and dangerous even to heavy tanks.

Artillery Storm Troops, by Colonel Blümner. A proposal to attach special artillery detachments to attacking infantry in order to take over all undamaged enemy guns in the first enemy position captured, and to use them immediately against the retreating enemy. The idea is not entirely new, as it is legislated for in German *Regulations for Fortress-warfare*, 1910, when specially trained storm-detachments of infantry, engineers and, when necessary, garrison artillery were to be sent forward with the attacking infantry to take possession of magazines and guns. *Garrison Artillery Regulations*, 1908, also referred to this. Nevertheless the point seems to have been forgotten, and Colonel Blümner has been unable to obtain evidence of any such provision during the Great War. He has, however, found plenty of instances where such storm-troops would have been of great value. Thus, Lieut. von Brandis writes that at Douaumont the German infantry completely overran a French battery before the gunners had time to get away, let alone put their guns out of action. While the infantry hustled and jostled each other in their eagerness to scribble battalion and company titles of the captors in chalk on the barrels of the captured guns, there was no one to turn them to use against the retreating French.

The author is able to give a successful example of improvisation, when a happy combination of artillery and engineer officers and N.C.O.s was able to get going revolving cupolas immediately after capture, first one with two 7·5-cm. guns, and then one with a 15·5-cm. gun, and to get all guns into action with observed fire and good effect. Trained artillery storm-troops for such purposes would be a great accession of strength to the attack.

The Electrification of Army Equipment, by Lieut.-Colonel Kubitza. The motorization and mechanization of armies is a subject which year in year out rightly occupies numerous columns of the military and military technical magazines of all countries. The object of this article is to show that, although electrical power is a valuable means towards mechanizing human and animal labour, a comparatively modest place in this literature is accorded to electrification of army equipment.

The author, in order from the very beginning to obviate all misunderstandings, announces that we are at present living in a period of transition which is paving the way to an "electric age" in the nearer or more remote future. In that age we shall shoot electrically and drive electrically.

He deals first with the different uses of electrical energy in an army with modern equipment, and brings them under eight heads.

(1) Searchlight service. This falls into three sub-divisions according to use, (*a*) for the troops, for close work mirrors up to 45 cm.: these are, now that the use of acetylene or of acetylene and oxygen is obsolete, exclusively accumulator-driven glow-lamps; (*b*) for the artillery, for distant work, mirrors from 60 to 200 cm.: these are allotted to field, fortress and coast defence artillery, but principally for

anti-aircraft work; (*c*) for the air force, for observation and for night flying. Both (*b*) and (*c*) are arc lights, and when not built-in have horse or mechanical traction.

(2) Engineer service. Under this heading electrical energy is required for (*a*) high-tension obstacles for the defence of frontiers and of positions of permanence: the potential to which they will be charged is 1,000 to 2,000 volts; a double row of obstacles 5 km. long takes about 30 kilowatts; usually the energy required will be derived from existing power network, but transformers and switches for all cases will have to be carried. (*b*) The driving of electrical tools and apparatus for field bridging, field fortification, building of dugouts, cutting, sweating, etc. The possibility of utilizing electrical drive for engineer equipment depends upon the nature of the work to be carried out. The suitability and/or permissibility of such drive is determined in the first place by military, and only in the second place by technical reasons. For example, for ramming for field bridges, apart from steam, which is obsolete, compressed air, oil engine or electrical drive can be used. The last named is by far the most favourable technically: but in the neighbourhood of the enemy, owing to the liability of the leads to interruption, electrical drive would be out of place. In the case of bridges being built farther back this military objection loses validity. As regards stone and rock boring, according to the present position of technics, only compressed air tools can do the work, and electrical drive need not be considered, or at most for driving the compressor. This question of suitability from a military point of view cannot be asked where electricity is without competitors, viz., with H.T. for obstacles.

In general, electrical energy necessary for the drive of engineer equipment is obtained from movable oil engine and dynamo combinations. Under favourable circumstances one can count upon connecting up with existing power networks.

(*c*) Light, ventilation and water supply. Lighting will in all stations of any degree of permanence be principally by electricity, such being furnished by accumulators, movable sets or permanent installations. The ventilation of shelters and dugouts is often necessary, and the more so when it is a case of getting rid of gas. For driving fans electricity is eminently suitable; also for driving pumps.

(*d*) Engineer workshops. The engineers need mechanized mobile workshops, the importance of which increases with the progress in mechanization of the army. This circumstance demands a continuous improvement in the equipment of the shops in order that they can keep pace with the army's ever-widening requirements. For the time and labour-saving machines which they use electrical energy is most suitable, viz., for turning, drilling, grinding, slotting, also planing, circular saws, bending, cutting and sweating. The total power requirement of such a travelling workshop will not exceed 10 kilowatts. It can also be advantageously lighted by electricity.

(3) Signal service. This, the first branch to use electricity for army purposes, hardly comes within the scope of these investigations. Line-communication and lamp signalling both fall in the category of weak currents, while wireless is principally concerned with high frequency. These are two special branches of electrotechnics, and the rule for the signal service as regards electric energy supply must be independence, for which it is accordingly equipped. Small stations are accumulator-fed, larger ones have their own oil engines and dynamos. Outside sources of energy would be called upon at most for accumulator-charging.

(4) Workshop service. This service, in addition to the engineer workshops already dealt with, includes mechanized mobile workshops for artillery, air force, tanks and M.T., to all of which the remarks as for engineers apply. There will also be ordnance workshops to be provided for, and these will generally be fixed. They will draw electrical power from existing networks. Nevertheless in order to satisfy urgent front-line demands ordnance will also require travelling workshops as above.

(5) Vehicles. A number of different vehicles use electrical energy either from accumulators or from built-in combination sets. They are field railway locomotives, self-propelled trollies on rails, armoured cars, tanks, tractors and dragons.

(6) Medical service. Electrical energy is required for lighting, for laundries and

disinfecting establishments, and for electrical treatment of patients. Power will as a rule be taken from local networks, but where this is not possible the engineers must be called upon to provide it by means of electric-light lorries.

(7) Supply service. For field bakeries electric power is specially suitable, since making no smoke they can be nearer to the enemy, and heating quicker than with fuel their turn-out is increased. Other requirements are for lighting, for tools in workshops, and for overhead travellers in large stores.

(8) Army Factories in the Home-country. This includes not only the property of the War Department, but also that of armament firms. Whether supplied with electricity from private or public power stations, steps must be taken to protect them against air attacks, and also to prevent sabotage. Provision must also be made for the increase of current they will need. Such measures strictly fall outside the scope of the electrification of army equipment, and are properly included among industrial measures for national defence.—(*To be concluded.*)

The Austrian Railways in the War. A review by Major Kretzschmann of a publication by the Carnegie Foundation for International Peace, following on *The German Railways in the War* (*v. R.E. Journal*, December, 1931, p. 750). The two accounts show striking resemblances:—Owing to years of organization in peace the immense work of mobilization and assembly at the frontiers running smoothly to schedule—mass movements from one frontier to another faultlessly carried out—occupation of railways in conquered areas—watering down of personnel—heavy wear and tear of rolling-stock—difficulties of replacement—enormously reduced performance by the time of the armistice, viz., down to 10%.

The reviewer has written an article full of interest, but much of the ground has already been covered by General Ratzemhofer's splendid series of railway articles reviewed in *The R.E. Journal* as they appeared in the *M. Mitteilungen*.

Standardization of Guns and of Modern Artillery Systems according to French ideas. This consists chiefly of extracts from articles in the *Revue d'artillerie* by General Challéat, Major Camps, and Lieut.-Col. Buchalet, and from General Herr's book, *L'Artillerie ce qu'elle a été, ce qu'elle est, ce qu'elle doit être.* There is also a double-page list of all the Schneider guns suitable for Divisional and Corps Artillery, *i.e.*, from 75 mm. to 155 mm., with data.

The Use of Gas-shell by the British as early as 1899. Dr. Rudolf Hanslian, the gas expert and author of *Chemical Warfare*, which was reviewed in *The R.E. Journal*, March, 1928, writes that Lieut.-General M.'s letter in the last number giving his experiences at the Battle of Colenso is very interesting, but that it in no way permits the conclusion of that officer that the shell in question used by the British was gas-shell. Both the description of the effect of the exploding shell as regards the canary yellow coloration by the gases of explosion, of great pertinacity, and also the results of the investigation of duds, point most clearly to the shell being simply badly-exploding, hence deflagrating, explosive shell. The picric acid derivate and sulphur found are also no proof of gas-shell. Dr. Hanslian amusingly concludes that Lieut.-General M.'s communication is in any case very valuable, in so far as it once more bears testimony to the fact how extraordinarily easy it is in the field to mistake explosive shell for gas shell. Very real and most important conclusions must be drawn for future wars. The use of gas is forbidden by the Geneva Protocol of 17th June, 1925, but the question of retaliation when the enemy starts using gas was left open. "Let us try to imagine how extraordinarily easily one of the opponents, on the ground of misleading reports from the front, may be led to believe himself justified in using gas in retribution, and this even without taking into consideration the effect of artificial chemical smoke, which can bring about similar confusion."

(*February*, 1932.)—*A Collimator Substitute.* A search for a substitute for the collimator on account of its high cost and the replacement difficulty has produced a black-and-white-striped wax cloth, 50 cm. × 30 cm., stripes 1 cm. broad, to be placed about 10 metres behind the gun, with its edges weighted by stones. The gun-layers

learn quickly how to align by bringing the vertical cross-hairs on to these stripes, and a battery commander, Capt. Kruse, in his enthusiasm, calls the invention "Columbus' egg," as belonging to the category of those things that one wonders no one has thought of before. Something of this nature is believed to have been patented by Goerz.

Poland's Artillery Strong Out of All Proportion, by Colonel Blümner. Under Marshal Pilsudski's strong hand, Poland's army has made such progress as to rank now next in strength to those of France and Italy. Of great importance also is the fact that the Polish Government entirely rejects the idea of disarmament. After opening thus, the author goes into the statistics, especially drawing attention to the strength of the artillery 1 : 3 against infantry, whereas in Germany the proportion are 1 : 5. He makes play also with :—Poland, 73 guns of sorts per million inhabitants; Germany less than 5 per million inhabitants, and lighter at that. Total guns might have been given by multiplying Poland's 73 by 30 and Germany's 4·7 by 63.

No exception is likely to be taken to Colonel Blümner's conclusion :—"This too powerful artillery on our eastern frontier before the gates of Berlin and actually, by means of the Polish corridor, in the midst of German territory, is a constant threat of war to Germany. We demand for our safety the return to adequate army establishments, which includes the re-introduction of heavy artillery."

The Advent of the Machine-Cannon, by Lieut.-General Schirmer. The inefficiency of the machine-gun against tanks and against modern aeroplanes has naturally produced the machine-cannon, of which an example is here described, and shown by three good photographs—the 2-cm. machine-cannon Solothurn. This cannon has a practical rate of fire of 200 to 220 rounds a minute. It fires a shell which reaches a height of 2,000 metres in 5½ seconds, and which is detonated on impact with even the least resisting portions of the aeroplane, breaking up into about 40 effective pieces. For anti-aircraft work the author says it must be completely automatic. Against tanks the 2-cm. armour-piercing shell pierces 25 mm. thick nickel-steel plate at 500 yards end on. It is thus effective against light tanks, and heavy tanks must be left to the artillery.

General Schirmer prophesies the early adoption of the Solothurn 2-cm. machine-cannon by all modern armies.

A New Instrument for Drawing Arcs. To overcome the difficulties attendant on the use of ordinary wooden curves an instrument has been constructed for drawing arcs up to $r = \infty$, but no acknowledgment is made to Euclid III., 21, for the fundamental principle. Some tasks are mentioned :—To draw an arc, given height and the length of chord ; to find the radius of a given arc ($= \frac{\text{chord}}{2} \times \frac{1}{\sin \beta}$, a table of reciprocals of sines being provided) ; to draw an arc of 85-cm. radius (tables give height of segment, and angle) ; to continue a straight line as a curve of given radius (beyond the power of the wooden curve !) ; to continue an arc of given radius to any length ; to join two intersecting straight lines by means of an arc of given radius.

The instrument is recommended to railway, road and military engineers. A photograph shows it, but no dimensions are given. It is made by the firm of R. Reiss, Ltd., of Liebenwerda, according to the design of P. Marx, of Lindenthal, Cologne.

The Electrification of Army Equipment (continued). Shows what measures were taken in the Austro-Hungarian army generally to meet the electrical needs of the various services enumerated in the last number. In that list of eight different services, all requiring electricity for their work, two only, searchlights and signals, were provided before the war with both material and personnel to that end. During the war, two more, the engineers and workshops, were provided for electrically on a very large scale. For these four services in future one central power station, however desirable in many ways, is out of the question owing to considerations of time, space and varying requirements. Lieut.-Colonel Kubitza therefore recommends that the engineers provide these services separately with mobile power stations, consisting of oil-engine and dynamo combinations carried on lorries, horse-drawn wagons or even

on two-wheeled trailers for mountain warfare. These should not be army equipment, except as necessary for training and manœuvres, so as to save storing and to keep up to date. Leading electrical firms should be interested in the subject, encouraged to work out and produce their own ideas, so as at any time to be ready to turn on to producing large numbers for the army on mobilization.—(*To be concluded.*)

Bridging Equipment in Foreign Countries. Discussing the 1925 French regulations on "Divisional Engineers, Their Tasks and Employment," in the *Revue du Génie Militaire*, Major Cabasse mentions new equipment for a light bridge up to 4 tons, carried by the Bridging Coy. which forms part of the Divisional Engineer battalion. This increase of 1 ton, as against the 3-ton bridge carried in 1914, appears thus to be the result of France's war experience.

In another number of the same journal Colonel Baills, in an article "Bridging Equipment in the Larger Formations of Modern Armies," makes several recommendations. He demands Kapok equipment for assault bridging. A division, having a 60-metre broad river to cross, could with the equipment carried by three 3-tonners, pour four streams of infantry across at the same time in different places. For the infantry guns something more is necessary and rafts of Habert's sacks are recommended. As regards the bridges necessary for the other arms the writer is all for trestles against pontoons. The division should have 60 metres of trestle bridge for a 9-ton load, and four folding boats. This amount of bridge will weigh 18 tons, and will require six 3-ton lorries to carry it, but the loads must be so light and handy as to allow of manhandling even over a good distance. As Corps bridges (120 metres of run) will also not need to take more than 9 tons, the Corps bridging material should be the same as the divisional. Only for deeper and broader streams they will also carry pontoons.

The same questions are dealt with by Major Vischer in the *Revue Militaire Suisse*, and in two articles in the *Military Engineer* of Washington. The answers given differ. The Swiss with their swift rivers prefer pontoons to trestles, and have produced a large but very light boat, 9·5 metres long and 1·8 metres beam. The Americans for ferrying pontoon rafts and also for single pontoons recommend outboard motors like the Johnson Seahorse, trade pattern, 16 to 24 h.p. The Engineer Equipment Committee has designed a hinged arrangement fastened to the stern so as to keep the engine 45 cm. above the surface of the water, however deep the pontoon is loaded.

(*March, 1932.*)—*What is the Proper Camouflage?* Major Kaiser, the author of the article on camouflage reviewed in the March *R.E. Journal*, page 180, is attacked, not without warmth, by a writer who remains anonymous. The chief bone of contention is Major Kaiser's inclusion of the single rifleman in his list of those who will in the battlefield of the future need to carry about with them their own camouflage. That this already overloaded individual should be called upon to do so is apparently the last straw. Major Kaiser's critic calls the proposal "absolutely not to be discussed." His own definition is that that is the proper camouflage which suits itself, according to means, extent and use, to the existing circumstances of the fight (attack, mobile or rigid defence); and not one which tries to determine the nature of the fighting to suit itself, for this in the end will always bring us back to defence.

The Electrification of Army Equipment. The general and military aspects of the subject having been considered, this final instalment deals with the electrical side. At some length Lieut.-Colonel Kubitza deals with the two main problems: D.C. *versus* A.C., and 110 volts or 220. Actually very few of the pros and cons here stated have any bearings on the case. The decision what nature of current to adopt and what voltage (*viz.*, alternating current at 220 volts) is arrived at because of the army's necessity of taking advantage of every opportunity of drawing electricity from existing civilian networks. In nearly all countries with progressing electrification, civil practice turns almost exclusively to A.C., and that at 220 volts. It

only remains to settle the questions of accumulator-charging and of the arc lights. For the first-named small transformers or other rectifying arrangements will have to be carried: while for the latter the field searchlights, having their own voltages and own D.C. equipment will remain outside the scheme.

The Hygiene of the Gas Mask. As regards the best disinfectant a fire-brigade officer, with several years' experience with gas masks, lays down the following requirements: the metal, leather or rubbered parts must not be attacked by the disinfectant: the process must be easy to carry out and cheap; the disinfectant must leave no smell. He characterizes the cleansing effect of soap and water, or of methylated spirit as mechanical only, rejects for various reasons sublimate, lysoform, formalin, chloramin and peroxide of hydrogen, and plumps for chinosol, a crystalline, non-hygroscopic, yellow powder, soluble in soft water. For ordinary use 1 : 1,000 is sufficient, *i.e.*, 1 gramme to 1 litre.

Foreign Opinions on Technics, Armament and Morale. The compiler of these notes has a good eye for a striking quotation. He lays under contribution this month not only his favourites like Colonel F. J. C. Fuller and Capt. Liddell Hart, but extends to Lloyd George and Treitschke. He quotes Lieut.-Colonel Gilchrist of the U.S. Medical Corps as saying, " For whatever attitude any particular country may take towards the new gas arm, its use in the next war is just as certain as that there will be a next war."

Treitschke's effort is, " Amongst all political sins, weakness is the most reprehensible. It is the sin against the holy spirit of politics. There are in private life excusable weaknesses of temperament. There can be no talk of any such thing in the State. The State is might, and when it fails to act accordingly, it cannot be too severely condemned."

Tank Strengths in the Most Important Countries. As far as the writer knows, and except in the case of Italy, the number of tanks has considerably decreased among Germany's former opponents, as compared with what they had at the end of the war. He thinks this is too good to be true, and that we must hold reserves of still usable old tanks.

He gives the following particulars:—France, 1,700 tanks on peace establishment, classified as:—

(*a*) Small, the Sabatier one-man tank on Kegresse track, with one m.g. or 3·7-cm. gun, 8 to 10 mm. armour, maximum speed 8 km. an hour, number of tanks not known.

(*b*) Light, 7 to 8 tons, 1,600 Renault and 6-ton caterpillar Schneider-Laurent, with one 3·7 cm. or 7·5 cm. gun in revolving turret, together with one m.g., or instead of the gun a super-heavy m.g. The Renaults do 7 to 8 or 16 to 18 km. an hour, depending upon their armouring, 30 to 22 mm. The Schneider-Laurents, with their 15 mm. of armour, can reach 45 km. an hour. They can also swim.

(*c*) Heavy, 70 to 95 tons, alone of their kind, 2C, 3C and D. The later ones carry 10 m.g.s and in revolving turrets one 15-cm. howitzer and two short 7·5-cm. guns: with their 50 mm. thick armour they are considered field-gun proof; maximum speed, 15 km. an hour.

Great Britain, 581 tanks in the Service. They include:—

(*a*) Small, 200 Carden Loyd Mark VI. and Mark VII. two-man tanks. According to the late Major Heigl (whose early death was a great loss both to the Austrian Army and to military science generally), the new Carden Loyd Mark VI. can replace an armoured car.

(*b*) Light, 5 3-tonners and 10 light Vickers 6-tonners.

(*c*) Medium, 220 12-tonners medium Vickers Mark I. and Mark II.

Under trial is a 16-tonner, armed with a 4·7-cm. gun and 5 m.g.s in revolving turrets, believed to be armoured to thicknesses of 20 mm. and 13 mm. Its average

speed of 25 km. an hour is said to be capable of rising to 50 km. an hour over the best country. Major Heigl rated it as "the future tank."

Permanent Fortification of Frontiers—Strategic Use—Armament—Occupation. General Culman's book, published by Charles Lavauzelle, Paris, is welcomed as filling a great gap in the literature of permanent fortification.

The Difficulty of Preserving Secrecy in War. Dr. Rudolf Hanslian, in *Gasschutz und Luftschutz*, gives the following instances of intended gas attacks being given away by deserters. The first use of a chlorine phosgene cloud against the British on 19.12.15, near Wieltje, was announced beforehand to the Chemical Adviser to the British Second Army by a German serjeant. Similarly were betrayed, to the Russians intelligence of the first German gas attack by cylinders near Bolimow, in May, 1915, to the Italians the first German gas attack, near Flitsch, on the Isonzo, on 24.10.17, and to the French the detailed plan of the gas bombardment at Rheims on 15.7.18. To these instances may now be added a very remarkable case. According to General Ferry, then commanding the French 11th Division N. of Ypres, a German deserter, August Jaegar, of the 234th Regt., 51st Division, 26th Corps, told the French officer-interpreter on the night of 14/15th April, 1915, near Langemark, of the first of all German gas attacks, which took place eight days later. French G.H.Q., to whom General Ferry reported, could not take the matter seriously, and rapped his knuckles for having informed the neighbouring British and Canadian formations direct, instead of through Corps H.Q.

Incendiary Bombs. Chief Engineer Rumpf has written this book (*Brandbomben*, E. S. Mittler & Son, Berlin; paper cover; 10 marks) expressly as a contribution to the air defence problem. He abstains from any judgment as to which form of bomb is the most dangerous, explosive, incendiary or gas. They are one and all very dangerous indeed, especially where all means of protection are lacking. The author's experience with fire-brigades in East Prussia qualifies him to advise on fire protection. His book brings out the danger of underestimating air attacks, often done on political grounds, the equally dangerous attitude of looking upon all protection as useless, and most dangerous of all, the intermediate ostrich-like position, which shirks the whole subject.

The Air Arm in Belgium. The Belgian Air Ministry's order for aircraft in England in 1931 has already been noticed, viz., 30 single-seater fighters, Fairey "Firefly" and Fairey "Fox" day-bombers. In January, sixty more of these machines were ordered, thirty of each, and, on the defensive side, six anti-aircraft guns complete with accessories from Vickers.

Sir Henry Wilson's Diaries. That a book should be written in German about the diaries of this "great German hater," "the bitterest enemy of Germany in British military circles," is regarded by General Schwarte as a matter of congratulation, the diaries themselves being considered indispensable to the student of war and pre-war history. The writer laments only that, presumably on the grounds of expense, a translation had to be foregone in favour of a compilation. He produces two plums for his public, those titbits which have almost become a standing-dish at the end of every review. On October 14th, 1913, General Wilson visited General Foch and they discussed thoroughly "our combined action in Belgium." And second, that in many places in the book, the anxiety of the Entente is expressed about their "eventual defeat."

The Great War of the Future—No Illusion! by Colonel Immanuel, published by Offene Worte, Berlin; 4 marks. The author believes that the problem of the present world crisis can never be solved by ministerial conferences or international congresses, but only by arms. He marshals the evidence which seems to point that way, demands the right for Germany to re-arm, and would replace the cry of "No more wars," substituting it by "No more defencelessness." Finally, a picture of the war of the

future, and good advice to Germans about their old faults, small-minded love of quarrelling and lack of unity. The reviewer hopes that the book will be very widely read.

F.A.I.

REVUE MILITAIRE FRANÇAISE.

(*January*, 1932.)—*La recherche de la décision*, by Général Faugeron. In this instalment the writer considers Ludendorff and the progress of his strategy from the original capture of Liège to the control of the German armies as a whole. He shows very clearly how, in everything that Ludendorff did in the early stages of the war, he was successful, and how consequently his ideas were bound to come into conflict with those of Falkenhayn, who relieved Moltke at the German Supreme Command. Ludendorff's policy was to kill Russia early and then turn on France; Falkenhayn wished to hold off Russia and keep the west as the main theatre. After the failure of Verdun, Hindenburg and Ludendorff were brought to the German Supreme Command, and here the writer shows how Ludendorff's policy tended to change and approximate to that of Falkenhayn, when he was with the Commander-in-Chief of all. Finally, the campaign of 1918 is considered and it is shown how Ludendorff's tactical successes led him away from his strategical objectives. Regarding the campaign after a considerable interval, however, one feels inclined to ask whether any man, however great a strategist, could have been successful.

Chef de bataillon Guigues finishes *Le Gouvernement de la Défense nationale* in this number. The fourth part of the article deals with services, such as transportation, maps, scientific methods of defence, etc. After a considerable period of failure with the railways, the government at last decided on a partial military control, which actually formed the basis of the satisfactory system used during the Great War. The fifth part deals with courts-martial and general discipline and gives an idea of how the French control their own court-martial system. The writer concludes by pointing out how the continual improvisation, which the national government had to make, could not really do more than uphold the honour of the people. Peace-time preparation is essential for the war organization of the country, and this was what the French did not possess in 1870–1.

Lieut.-Colonel Larcher finishes *Le 1er corps de la Belgique à la Marne* with a description of its retreat after the battle of Guise till General d'Espérey was given command of the Fifth Army, just before the battle of the Marne. The retreat was very hard on the men, who were almost worn out for lack of sleep, but they managed to keep clear of the Germans except for the cavalry, who covered the retreat satisfactorily. The chief difficulty was for the staff as there were four corps on thirty kilometres of front, so that there were countless checks and the men slept where they stood. The article concludes with an appreciation of Franchet d'Espérey's training of the men in peace for their task in war, and it is of interest to note that he said, in the summer of 1914, that the war would last years and be of the most bitter description.

In completing *La 10e armée russe et le désastre d'Augustovo*, Colonel Aublet describes the complete annihilation of the 20th Corps. Acting as a flank guard to the Russian Army, and supplied with practically no information, they were cut off completely in February, 1915, by the Germans. The story is the same as usual with the Russians, lack of information and orders impossible to carry out against the well-organized German forces. This particular corps was brave enough and had certain successes at first but it could not stand against the German enveloping movement.

Général Chauvineau begins *L'organisation du terrain à une aile* in this number. He describes a scheme, Blue (on the east) defending the southern flank of a chain of armies against Red, with three river lines available, the Madon, the Moselle and the

Meurthe. The article is written in considerable detail and should be of particular interest to the Sapper, as careful calculations and strengths of working parties are explained at great length. The writer begins with the method of holding river lines, as suggested by Marshal Pétain in 1918; his system being that the heavier the attack the farther behind the river should be the line of defence. He then turns to the troops available for this defence, and finally discusses how the engineers and explosives are to be used. There is no space here to go into details, but General Chauvineau works out what is required from first to last. It is apt to be heavy reading for anyone going through the instalment quickly, but it should be of use to the serious student.

(*February*, 1932.)—This number's instalment of *La recherche de la décision*, by Général Faugeron, deals with Foch. The writer is obviously an enthusiast and considers that Foch is one of the greatest soldiers of history. He points out that when Foch took over Commander-in-Chief at Doullens, on 26th March, 1918, he had to avoid defeat rather than to try for victory. This he did by placing his reserves so that Ludendorff was forced to attack on less important parts of the front, such as the Chemin des Dames, than towards Amiens or the Channel ports. Then, when July arrived, Foch began his series of brilliant offensives, his system being to go on attacking, not on very wide fronts, but continuously. We all know how the Germans were defeated and accepted the Armistice. What one cannot really grasp, even yet, is whether the Germans could have been successful in 1918, or whether Ludendorff, for instance, would have had the same success as Foch. This must be left for the next generation to make up their minds over.

Général de Cugnac describes three months of combined operations in *Yorktown*, 1781. The Americans were approaching their last gasp when the French declared war on England. The main British force was at Yorktown, under Lord Cornwallis, in 1781, but another force near New York, under Clinton, who was theoretically his senior, failed to co-operate with him. The Franco-American operations were really well carried out, which was more than could be said for the British. Grasse, the French Admiral, defeated the British fleet, under Hood, at Chesapeake Bay, after which American and French troops were able to besiege Cornwallis at Yorktown. Eventually the British were forced to capitulate as they received no support by land or by sea. The campaign is of distinct historical interest as the allies were successful in their combined operations, but at the same time the British showed a lack of vigour which, fortunately, was not to be found twenty years later during the war with Napoleon.

Comprendre, by Capitaine Carrias. This is the first instalment of an article dealing with what a great commander, as stated by Foch, requires, viz., to understand, to decide and then to direct. This instalment begins with Napoleon at Waterloo and how, by failing to acquire the necessary information about Wavre, he suffered a heavy defeat. Capitaine Carrias considers that if he had had a 2nd bureau, an intelligence section, he would not have fallen into the error and would have then been successful at Waterloo. The article is well written and interesting.

Chef de bataillon Durand describes the action of our tanks in *L'emploi des chars à la bataille de Cambrai*. The article only deals with the first stage of the battle and describes how the British troops advanced successfully for forty-eight hours with a mass of tanks under General Elles. The lessons from the battle are quite clear, but one cannot help wishing that the whole of Cambrai, instead of only one part of it, was described. As what was really the first real tank battle, one feels that it should be treated as a whole.

Général Chauvineau completes *L'organisation d'un terrain à une aile* in this number. The problem is the partial withdrawal of a force facing west on a switch against a force facing east, about the Moselle area. General Chauvineau gives considerable detail, both on how the switch line should be drawn out and how the work should be carried out. This article is certainly for the keen student rather than the general reader; there is no doubt that there is a great deal to be found by a careful study of it.

(*March*, 1932.)—In this number Général Faugeron finishes *La recherche de la décision*. He begins by again considering Foch and how he was really the first to realize how the enemy could be worn down and how both the French and the British failed to understand the lessons of the attacks on both sides before the year 1918. General Faugeron considers that by attacking first on one part, then on another part of the front, without continuing to allot reserves to each part in turn, in time the enemy were fixed without a big reserve. Then was the time for them to be really defeated, and it was owing to the approaching defeat that they signed the Armistice. The difficulty is that no one can say if this success could have been brought off earlier, probably not. The writer concludes by a very long discussion of his conclusion, namely, that the enemy must be fixed before he can be defeated, and gives many examples through history. Here again one feels that the time since the Great War is too short for one to really make up one's mind about it; and in all previous wars, forces were so much smaller that they cannot be compared with those of the Great War.

Général Brossé begins *Les fronts de combats* in this number. He discusses all the various stages passed through during the war, in attack, defence, covering troops, etc. The article is not of particular interest unless one is studying this particular branch of tactics, but the writer does make the different stages very clear, and it is interesting to note that the front of a division in the Vosges was ten times that on the main part of the Western Front.

Capitaine Carrias continues *Comprendre* in this number. The instalment deals with Grouchy's actions while Napoleon was being defeated at Waterloo. One naturally thinks again of the writer's statement in the first instalment that the existence of an intelligence section would have prevented Grouchy's failure and probably produced a great success instead of a miserable failure for Napoleon. On the other hand, one must not forget that Great Britain also had no staff constituted like the present-day staff and one can hardly expect Napoleon to possess a complete staff and Wellington none at all. After all, both sides made mistakes and unfortunately for the French, Napoleon, having less men than the British and Germans, was finally defeated. Captain Carrias, however, sets out Grouchy's action throughout the campaign very clearly and one can see how Grouchy might have brought Napoleon the assistance he wanted.

Colonel Charbonneau begins *La grande guerre sur l'equateur* in this number. The first instalment deals with the various columns from French, Belgian and British parts of Africa and the ways in which they were supplied by steamboats, porters, ferryboats, etc. A difficulty, which made the campaign harder than ever, was that the Germans, knowing that they could get no reinforcements, would never risk a battle, if possible to avoid one. The writer, who comes from the colonial troops, quotes Kitchener's remark in South Africa: "We now know the tactics of the Boers; with people who will not attack, we must be really daring." What Colonel Charbonneau deduces quite rightly from the operations are lessons for later savage campaigns, such as that against Abd-el-Krim in 1926. The instalment concludes with a description of the extreme difficulty in feeding the troops; even the Europeans often received meat not more often than twice a week.

Capitaine de Lassus contributes an important article called *Les grandes manœuvres allemandes*. These were held in 1930 and dealt with bigger formations than were actually on the ground by the use of cadres instead of complete formations. It is interesting to note that all military attachés, except those from France, Belgium and Poland, were invited. The actual manœuvres took place in Thuringia, east of Frankfort on the Main. There is no space here to describe the operations, but it is obvious that a war of movement was continually aimed at, and that the troops and commanders were well trained to break off and manœuvre both by day and by night.

H.A.J.P.

REVUE DU GÉNIE MILITAIRE.

(*December*, 1931.)—Under the heading *Le Paratonnerre et ses Progrès Récents*, Lt.-Col. Chancenotte reviews an article published in the May and July numbers of the *Revue des Questions Scientifiques*, published in Brussels. The author regrets that there are hardly any investigations into the protection of buildings against lightning published in the French language. A series of photographs taken by Walter confirms the theory that a flash of lightning consists of a series of five to ten elementary discharges, often many more, all travelling in the same direction, at intervals varying from 0·0026 to 0·144 of a second, and each lasting 1/40,000 of a second, or even less. Under the action of the wind, however, there may be a space of several yards between the paths of these successive discharges, and the last discharge has a tendency to leave the conductor and strike out a path across any object offering less resistance than the air. The writer points out that some of the instructions given in the "Code for Protection against Lightning (1929)" are of very little value, especially as regards the area protected by each lightning rod. It is a great mistake to suppose that the proximity of a tree to a building affords any protection.

There is no such thing as a "good earth" for lightning. Since water is 1,000 times a better conductor than dry earth, it used to be considered that a flash of lightning could be discharged into the ground by providing contact with an underground layer of water, or, at any rate, with damp earth. Tests of resistance by the Wheatstone bridge method must, however, be accepted with caution, since resistance to lightning depends more upon dielectric rigidity than ohmic resistance. It has been proved that the rigidity of the soil varies very slightly with the amount of water that it contains.

The writer discusses the Melsens system—of a double Faraday cage—for the protection of petrol tanks or powder magazines, without coming to a very definite conclusion. He goes on to discuss the fallacy of the preventive action of points—Franklin's original idea being that they produced a complete discharge—whereas it has been shown that even with the finest point there is always a residual potential of one or more thousand volts.

Reinforced Concrete and its Application. This article, by M. A. Caquot, is taken from the *Annales des Ponts et Chaussées*, for March-April, 1931.

After discussing elementary principles, the writer points out that the manufacture of steel has already been brought to such a state of perfection that no very great progress is to be anticipated in future. On the other hand, the cement industry is in its infancy, and very considerable improvements may be looked for. In actual practice the compressive stress on concrete barely exceeds 200 kg. per square cm., whereas, if the mixture were absolutely compact, the materials of which it is composed should stand a stress of 2,000 kg. per square cm.

Two physical phenomena, viz., shrinkage, and variation of the coefficient of elasticity, are bound up with the porosity of concrete, and will disappear when, by perfecting methods of construction, it will be possible to obtain a concrete free from voids. Nowadays, in actual practice, the proportion of voids in concrete is found to be not less than 16 per cent. Recent investigations by Adams and Bolomey show that, as concrete is improved by increasing its compactness, its compressive resistance is increased in a higher ratio than its resistance to tension.

Former regulations did not lay sufficient stress on the importance of transverse reinforcement, and there has been a tendency to provide an unnecessary number of longitudinal compression bars, without making provision against buckling by introducing sufficient transverse reinforcement. The temper of the steel used is most important. The elastic limit varies from 24 kg. per square mm. for soft steel to 60 kg. for hard steel. It is practically useless to employ soft steel for reinforcement: only hard steel should be used.

Reinforced concrete construction originated with the French, and, even nowadays,

the most remarkable examples of this form of construction are to be found in France. The arches of the largest span are those of Plougastel and Les Usses; the most important straight girders are those of the Ivry and Lafayette bridges; the largest bow-string girders are those of the Lucien-Saint bridge in Tunis. There is still room for numerous improvements in construction. It is probable that in the near future we shall see great strides made in the electric welding of steel, and, as regards concrete, the employment of steel sheeting for shuttering, and ramming by vibration are likely to be extensively used.

Les Communications Radiotélégraphiques dans l'Armée. This article is concluded in this number. The author discusses wireless communication between aeroplanes and ground stations, and in the reverse direction. The enemy has two courses open to him: he can intercept messages, or he can interfere with the reception of messages; he cannot do both. The author considers the interception of messages the worse evil of the two, and discusses methods of dealing with it.

Other points dealt with in the article are:—(a) radiogoniometry, or the technique for determining the direction from which wireless rays are transmitted; (2) teleidography, which includes the radio-transmission of images; (3) radio-telephony; (4) television; (5) special motor-cars for transporting radio stations.

(*January–February*, 1932.)—In *Le Génie dans la Bataille sur les Cours d'Eau*, Colonel Baillis commences a series of articles in which he discusses the importance of water channels on the modern battlefield. Water channels exceeding 1 m. in depth and 4 m. to 6 m. in width are the most effective obstacles against light armoured cars, and hamper very considerably the progress of any mechanical vehicle whether mounted on wheels or caterpillar tracks. The tendency is for mechanical transport to grow more powerful and consequently heavier. Engineers are therefore obliged to use increasingly heavier bridging material.

In the reconnaissances that take place during the preliminary movement of an army, it is essential that a number of engineer officers should be attached to the cavalry, and that they should report on the crossings of water channels and on the local material available. During the earlier stages of a campaign, local resources should be utilized fully, and as little strain as possible should be placed on the base supplies until industrial mobilization has been fully organized.

Qualified engineer officers should be trained as observers and should take part in aerial reconnaissances. They should learn to interpret the details of aerial photographs. The author goes on to describe instances of passages of rivers during the Great War on the French, Austrian, Rumanian and Italian fronts.

In *Utilization de la Chaleur Solaire*, Surgeon-Colonel Pasteur describes a method of utilizing solar heat to provide a supply of hot water in a hospital at Colomb-Béchar —many miles inland on the Algero-Moroccan boundary. In spite of the strictest orders against felling, the region in question has been denuded of its timber, and firewood is extremely scarce. The author, who has made a special study of solar radiation, was asked to make practical tests at Colomb-Béchar. It has been shown by physicists that the amount of heat that reaches us from the sun, at the outer limits of the atmosphere, is approximately two calories per square centimetre per minute. This is known as the "solar constant." A portion of this is absorbed or diffused by the atmosphere. The maximum heat obtained on the earth's surface is 1·5 calories per square centimetre per minute: on fine days the mean average varies between 1 calory and 1·3 calories.

After various preliminary experiments, the author devised a type of apparatus that he describes at some length. Put briefly, the installation adopted at the Colomb-Béchar hospital consisted of a series of 18 radiators, laid in a row on a sloping verandah roof, interconnected with one another, and with the necessary tanks, pipes and stop-cocks. A drawing and a series of photographs illustrate the arrangement. The output of the installation, during a time of year when the heat was not excessive, was,

on an average, 30 litres of water at 90°, 60 litres at 65° and 200 litres at 40° per square metre of heating surface per diem.

Owing to the high price of fuel, the cost of a hot bath was formerly three to five francs. With the sun-heated apparatus 10 to 15 baths per day can be provided, with no cost whatever for fuel.

Under the heading of *Les Auxiliaires de la Couverture*, Capt. Mandaroux describes what he calls "Covering Operations," that is, a series of strategic operations that are carried out between the time of the first reinforcement of the frontier guards in peace time and the completion of mobilization and concentration. The article is subdivided into "Co-operation of the Air Force" and "Covering Demolitions." Under the latter head an article, published in the *Militär Wochenblatt*, of April, 1930, on the "Employment of Barrages in Modern Operations," is quoted at some length.

A.S.H.

JOURNAL OF THE ROYAL SANITARY INSTITUTE.

(*February*, 1932.)—*One Pipe System of Drainage*, by John Fyfe, A.M.I.S.E. To few of us is it given honestly to appreciate the æsthetic value of drainpiping on building façades.

To fewer still is the logic apparent of legislating against the discharge into the same downpipe of wastes, originating possibly in the same room, and united into the same drain a few feet away from the house wall. This is the dogma which Mr. Fyfe sets out to attack.

Among the points in favour of his contention are the following:—

(i) The downpipe already receiving the waste from basins, baths and sinks would be cleansed more thoroughly if it also received the flushes from W.C.s.

(ii) Gully traps are sealed by accumulations of filthy water and are therefore insanitary. These are obviated in the one pipe system.

(iii) The fear that bath traps may become unsealed owing to prolonged disuse is grossly exaggerated.

It is not clear how the author proposes to deal with rainwater pipes, and his arrangement of internal ventilating pipes seems unnecessarily elaborate.

The support given to his theories in the ensuing discussion is a striking indication of the modern trend of thought.

(*March*, 1932.)—*The Discussion on the London County Council Drainage By-laws.* The discussion was prefaced by Lt.-Col. W. Butler, M.B., D.P.H., who put forward the point of view of the compiling committee, the chief point arising from his statement being the change in legislation, whereby interceptor traps are no longer obligatory.

This is a matter of interest to officers on works services who are responsible for the design of drainage systems.

The factors are as follows:—

(i) The intercepting trap, by cutting off the drain from the sewers, also cuts the sewers off from the ventilating pipes at drainheads. Thus sweet drains are obtained at the expense of foul sewers.

(ii) The stopper of the cleaning eye is liable to be displaced with the result that sewer gas emerges through the F.A.I. to the detriment of adjacent habitations.

(iii) The trap is susceptible to blocking, and if this occurs the drain ventilation system breaks down as the F.A.I. is cut off from the V.P.

(iv) For the retention of the trap, it is argued that it is unfair to expect the householder to bring the stink from the public sewers to an exit on his private house wall, if he can avoid it by using this fitment.

A further point of interest arose in the admission that from the sanitary point of view there was no objection to combining the duties of R.W.P. and V.P. in the same pipe, provided that it complied with the specification of the latter. This might be considered in conjunction with Mr. Fyfe's proposal of a One Pipe System, which is reviewed above.

A.D.C.

THE JOURNAL OF THE CHARTERED SURVEYORS' INSTITUTION.

(*March*, 1932.)—*Causes, Consequence and Cure of Damp in Buildings*, by R. Fitzmaurice, B.SC., A.M.INST.C.E. This is a very striking paper, and is rendered even more authoritative by the author's position in the Building Research Station, Department of Scientific and Industrial Research. Starting with a brief review of the consequences of damp in buildings, he proceeds to investigate the behaviour of water in contact with building materials. In this section the effect of surface tension, pore-structure, external ventilation, condensation and water repellence are outlined. The problem of excluding damp under practical building conditions is then faced under four headings:—(i) damp rising from the ground; (ii) damp passing through the roof; (iii) damp passing through the walls; (iv) condensation.

In the first instance, site drainage and intelligent siting of D.P.C.s are obvious measures, but the author's suggestion for breaking the capillary path through a bed of hard core by eliminating all fine material is interesting.

In the second instance, the danger of torching tiled roofs is emphasized.

In the third instance, the wall units, *e.g.*, bricks, are considered separately from the jointing mortar. A good case is made out for the unfilled cavity wall, and the injurious effects of over-meticulous pointing are indicated. Dry walling and the isolated inner lining for existing damp walls are also commended.

Ventilation and heat insulation are suggested as suitable measures in the fourth instance. The paper concludes with a brief review of the methods of curing damp in buildings.

Waterproofing substances are tabulated under three headings:—(*a*) pore fillers; (*b*) water repellents; (*c*) continuous surface films. Of these the first class are not recommended, the second class are usually colourless but not always effective, and the third class, though usually effective, inevitably result in a drastic alteration in the appearance of the walls.

A new type of coloured bitumen emulsion is favourably mentioned.

A.D.C.

CORRESPONDENCE.

THE BLACK HORSE.

The Editor, *The Royal Engineers Journal.*

DEAR SIR,

I notice in the issue of *The R.E. Journal*, of January, 1932, that Captain Baker lays claim to the Black Horse badge for the 7th Field Company.

May I point out that this is the badge of the 23rd Field Company and has been at intervals for a very long while?

The basis of the claim of the 23rd Field Company to this badge is the fact that it was the first mounted unit to be raised in the Corps as the 23rd Company, Royal Sappers and Miners, in 1865. When formed into a Field Company in 1885, it was then known as the "Black Horse." Amongst other names it has had have been "The Old Battery" (origin unknown) and the "Old Lucky Company," but of recent years we have reverted to our original unofficial title and wear the likeness of a Black Horse on our sports jerseys, etc. It seems curious that two companies in the Corps should both take such a distinctive badge, and it would be interesting if any connection could be traced between the two.

Yours faithfully,

J. SPOTTISWOODE, *Major, R.E.*
Commanding 23rd Field Company, R.E.

Aldershot.
29.3.32.

The Editor, *The Royal Engineers Journal.*

DEAR SIR,

The letter from Major Spottiswoode, in which he lays claim to the Black Horse badge for the 23rd Company, has led me to make further research into this matter.

I have, however, been unable to establish any conclusive evidence to substantiate the claim of either company.

The History of the Corps of Royal Engineers, Vol. II, by Major-General Whitworth Porter, gives the following information about the early days of the 23rd Company:—

Formed April, 1855, and composed of mounted men to form the nucleus of an engineer train.

April, 1857. The 23rd, or Driver Company, was converted into a troop and a new 23rd Company formed (presumably dismounted). It then went to China but was diverted at Singapore and sent to India to take part in quelling the Mutiny. It proceeded to China

in 1859. From 1861–71 it was at Chatham. 1871–1885, Sub-mining Depot Coy. at Chatham. In 1885 it was deprived of its number and formed into "M" Company. A new 23rd Company was raised at Aldershot in 1885 and remained there until 1889. It was raised as a Field Company.

It will be seen from the above that the early life of the 23rd Company as a mounted unit was only two years, and that the Company has been reconstituted twice since that date. It is, therefore, unlikely, though, of course, possible, that the name "Black Horse" dates from the early period, and is more likely to be derived from its Field Company days at Aldershot *circa* 1885.

I have written to several officers who served with or knew the 7th Company in 1885.

Sir Ralph Anstruther, Bt., has informed me that, to the best of his recollection, the 7th Company was called the Black Horse in 1885 in Bechuanaland, and Colonel Pridham, C.B.E., D.S.O., says definitely that it was so known in 1894. Major C. E. Salvesen and Colonel C. E. Haynes, C.B., both of whom served with the Company in 1884/5, cannot recollect that the Black Horse badge was then used.

The 7th Company was raised many years before the 23rd Company, but became a Field Company at the same time in 1885.

Both companies were at Chatham for part of 1885, and may have been closely associated and it is even possible that, when the 23rd Company was changed to "M" Company at that time, the 7th Company "pinched" the badge, if it then existed; but this is all conjecture.

It would be interesting if the 23rd Company could trace the origin of the Black Horse to 1885 or even farther back.

As to the derivation of the name, it has been alleged that, as far as the 7th Company were concerned, the name was copied from the 7th Dragoon Guards who were so known, but this cannot be proved and, if the name goes as far back as 1885, I am inclined to doubt it, as they do not appear to have been associated with the 7th Dragoon Guards. Several officers have, however, stated that they understood that was the origin, but no proof is forthcoming. Field Companies were, however, considered to be almost cavalry and copied their ways. I think it is more likely that both the 7th Company and the 23rd Company were horsed with black teams and derived their names from the same source at about the same time. It is, after all, a very likely name to adopt under such circumstances. That the 7th Company were so horsed back in the 80's I have reasonable proof.

Whatever be the truth of the matter, which I fear is buried in the gloom of past days, it is rather unfortunate and I hope a happy solution may be reached.

If I may put forth a suggestion made by Colonel E. Holt-Wilson,

the 7th Company should call themselves the Old Black Horse, which I have often heard used in relation to them and to which they are entitled by their more ancient origin. The badges could be made different and easily distinguishable, as there are many variations possible in heraldic horse design.

Yours faithfully,

Dover.
26th April, 1932.

H. A. BAKER, *Captain, R.E.*

MECHANIZATION AND DIVISIONAL ENGINEERS.

C.R.E.'s Office, Quetta.
29th January, 1932.

The Editor, *The Royal Engineers Journal.*

SIR,

In his interesting article (December, 1931) on "Mechanization and Divisional Engineers," Lieut.-Colonel Fitzpatrick states that the best form of air compressor is still undecided.

It will interest many of your readers to know that we have had in use in Baluchistan for nearly three years compressors, made by Messrs. Holman, of Camborne, which are carried on two-wheel trailers. These can be towed at 40 m.p.h., if necessary, behind suitable lorries, and can easily be manhandled at the site of work. They are robust, and will work two rock drills at an elevation of 7,000 ft. above sea level.

Apart from one or two weak points, which the firm are remedying, they are just what is required for a field company, and have been used here successively by the Sappers and Miners, Hazara Pioneers and civilian labour.

In addition to rock drilling they are satisfactory for any other pneumatic tool—riveters, etc.—and have been used for cleaning choked tube wells, in some cases blowing out stones four inches in diameter. They will also blow water up from a tube well without any apparatus other than an air pipe and, when attached to a "Quimby" centrifugal air-driven pump, form a very useful form of power pump for active service or fire-fighting purposes.

In my opinion, a two-wheel trailer is far the best way of mounting a portable air-compressor for military purposes. Mounting it in a lorry merely locks up a lorry without producing any countervailing advantages, and transport is the one thing which has always been deficient at the beginning of a campaign.

In short, the Holman Compressor would seem to be exactly what we want.

Yours faithfully,

E. ST. G. KIRKE, *Lt.-Col., R.E.*

GENERAL SIR CHARLES PASLEY, K.C.B.

THE articles which have been appearing on the above subject in *The Royal Engineers Journal* have been reprinted in pamphlet form, and can be purchased from the office of the Secretary, Institution of Royal Engineers, Chatham, price 1s. 6d. each.

DATA, FORMULÆ, AND TABLES FOR STRUCTURAL DESIGN.

by MAJOR V. P. SMITH, R.E., and LIEUT. H. S. JARDINE, R.E. (T.), A.R.I.B.A., 1919. Price 1s. each.

COOMBE HOUSE, CROYDON.

R.E. officers are reminded that they and their dependents may be received at Coombe House as guests when they are in need of a rest or change. It offers a haven for a time to officers when retiring or going on half pay, or while looking for a permanent home on returning from abroad.

Coombe House is situated at the foot of the Addington Hills, about two miles out from East Croydon, whence trains run to Victoria every twenty minutes. The house and grounds are delightful. Those who have been there have greatly appreciated them, and all the arrangements made for their comfort by the retired officer and his wife whose hospitality has prompted the scheme.

It may be desirable to state once again the few conditions which apply to Coombe House.

(1) Guests are not expected to contribute in any way.
(2) The maximum duration of a visit is 28 days.
(3) R.E. officers on the active and retired lists, their families (with the exception of children under 16), and the widows of R.E. officers are invited.
(4) Those who wish to go to Coombe House during a period of convalescence must have reached such a stage of recovery that they are able to return to normal diet, and do not require meals brought to their rooms.

The accommodation limits the number of guests to four at one time. With this limit it is necessary at times to arrange for selection among applicants, and adjustment of the dates for visits. The responsibility for these arrangements rests with the R.E. Corps Committee. Applications should therefore be made to the Secretary of that Committee in person, by telephone, or by letter. The address is Room 231, War Office, and the telephone number Victoria 9400, Extension 467. No particulars are normally asked of applicants, other than the dates which would be most convenient to them for their visits. Applications are, of course, treated as confidential.

ROYAL UNITED SERVICE INSTITUTION.

In order to assist officers to secure the benefits of membership of the Royal United Service Institution during the present difficult times, it has been decided to suspend the entrance fee entirely until the 31st December, 1932. Officers of all ranks whose names appear on the current official lists can, therefore, join the Institution during the current year by paying the annual subscription of £1 5s. only. Membership will date from 1st January.

On and after 1st January, 1933, commissioned officers of three years' seniority or more will be required to pay an entrance fee of £1 1s., but this will not apply to junior officers, who will continue to be admitted without an entrance fee, on payment of their first annual subscription. Life membership is twenty guineas or four annual instalments of five guineas.

For further particulars apply to the Secretary, Royal United Service Institution, Whitehall, London, S.W.1.