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THE INSTITUTION OF ROYAL ENGINEERS.

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"Q" IN THE EAST AFRICAN CAMPAIGN, 1941.

An Episode.

By BRIGADIER A. C. DUFF, O.B.E., M.C., R.E.

WHY should an article entitled "Q" in the East African Campaign" be published in *The R.E. Journal*? The suggestion that no other Journal would publish it would be equally insulting to *The R.E. Journal* and to the writer, and a better answer is that the Royal Engineers and "Q" have very close affinities. They both deal in facts and figures, things that are matters of calculation; and they both know that serious mistakes in their calculations will lead to failure clear for all to see; the bridge breaks, or the troops starve. It seems likely that a Sapper training is no bad foundation for "Q" duties. A Sapper is used to working out problems of time and space, tools and loads; he is not frightened by a sheet of paper covered with figures; he has some knowledge of what is meant by transportation; and he has often acquired to some extent an instinctive recognition of arrangements that are workable and of arrangements that are not.

If further excuse is needed for offering this article to The R.E. Journal rather than elsewhere, it may be added that the two A.Q.M.Gs. of East Africa Force, throughout the campaign and for the six months preceding it, were both Sappers. One was the writer ; the other was Brigadier Sir B. H. Robertson, Bt., D.S.O., M.C.

The East African campaign of February to July, 1941, deserves some study. The armies engaged were not of the same magnitude as those employed in European theatres of war : the ration strength of our forces in East Africa, including Base and L. of C. units and depots, never, at its peak, exceeded 150,000. Yet for rapidity of movement, maintained over very long distances, no campaign in this war or the last can show a parallel. The striking force that left the River Tana in February, 1941, moved in a vast semi-circle through Kismayu, Mogadiscio and Harar to Addis, which fell on 6th April; a distance of about 1,500 miles covered in three months; and in another two months had advanced another 300 miles westward, and extinguished at Gimma and Dembidollo the last embers of Italian resistance in Southern Ethiopia.

Writing so soon after the event, some discretion is still needed, and the names of formations and units have mostly to be suppressed; but "Q" is more concerned with numbers than with names, and their omission makes little difference to the following discussion of some of the difficulties that were encountered, and of the attempts made to overcome them.

The episode selected for description covers the second half of January and the first three weeks of February, 1941, when a force of two Divisions was advancing from the line of the River Tana to Kismayu and the line of the River Juba, an average distance of 250 miles through completely waterless desert. The other part of our front on which active operations were in progress at the same time was several hundred miles further north, where two South African Brigades were concentrating at Marsabit, and moving across the Abyssinian frontier to encircle Mega and outflank Moyale. These northern operations should be borne in mind in reading what follows, for the resources at the disposal of Force H.Q. had to be divided between the two theatres of operations, and "Q" had always to be prepared to switch transport or stores, in emergency, from one to the other.

* * * *

The scene of action of this episode lay in the area bounded on the southwest by the Mombasa-Nairobi railway and on the north-east by the River Juba. Half-way between these two boundary lines runs the River Tana, through Garissa and Bura and on to the sea.

The Force that took part in the operation was based on a railhead at Thika,

30 miles north of Nairobi, where the Garissa road comes in from the east. Thence the Force was supplied by road to Garissa. From Garissa onward the advance followed two lines; the first to Afmadu *via* Liboi; the second to Kismayu (Chisimaio) *via* Bura.

The map unfortunately does not show relief. Nairobi and Nanyuki stand high, about 5,000-6,000 feet. To the east the country falls away rapidly, and Garissa, Bura, Afmadu and Kismayu all lie on a flat plain nowhere more than a few hundred feet above sea-level. The same plain stretches away to the north as far as Wajir and Dolo, and then begins to break up into the foothills of the Abyssinian mountains.

This vast plain is all bush country. In some places the bush is so dense that it is difficult for a man to force his way through it; in others so sparse that the visibility may extend to some hundreds of yards. But in type it varies little. The taller trees are flat-topped, averaging perhaps fifteen feet high; the lower growth is grey or yellow thorn-bush, covered with spikes like barbed wire. The soil beneath is sandy, and for ten months in the year, bare. (See Photo I.) Only after the spring rains there is a sudden growth of green grass. At the same time comes the brief flowering of the thorn scrub and a rush of wild flowers, and for a a few short weeks the desert does indeed blossom like the rose.

This low-lying plain is intersected by the equator, and but for the breeze the heat would be extreme. The breeze, fortunately, is almost unfailing, and blows always from the same direction. One is used to sceing trees in northern countries lying over away from the prevailing wind. In Tanaland the trees and bushes are too stiff to take a permanent slant, and by some freak of termite architecture, it is the tall red ant-hills whose peaked summits lean over in parallel.

The two great rivers of this country, the Tana and the Juba, are much alike in appearance and in character. As one approaches the river line, the bush suddenly changes to tropical forest : tall evergreen trees, palms and interlacing creepers. After a mile of this comes the river, perhaps a hundred yards wide, running between steep banks ; when in flood, twenty feet deep and a racing torrent ; at other times little more than a chain of pools in a sandy bed, fordable without difficulty. (See Photos 2, 3 and 4.)

Apart from its two rivers, the country is entirely waterless. After the rains a certain amount of surface water lies for a short time in muddy pools—these are the various "laks" marked on the map—but otherwise the land is a desert in spite of its covering of trees and scrub. It is, in consequence, almost uninhabited, and its only industry, cattle-raising, hugs the banks of the rivers. The place-names shown on the map, such as Garissa and Bura, represent only the house of a District Commissioner or Police Officer, and a huddle of a few scores of mud and wattle buildings. Three-quarters of the localities marked on the map contain no buildings of any kind.

Game abounds in the vicinity of the rivers; elephant, lion, rhino, giraffe, buck and gazelle. The bush, too, is full of bird life. The two most common birds are the hornbill, which flies in a series of slow swoops—climb, stall, recover—climb, stall, recover; and the African starling, an amazing combination of vivid blue and scarlet. Reptile life is not lacking; there are crocodiles in the water and snakes on the land. It is in insect life, however, that the bush is particularly distinguished. The number of creatures that fly and crawl and buzz and bite and sting is legion.

There were two roads of sorts leading from Kenya to Jubaland; the southern road, from Thika to Garissa, Afmadu and Kismayu; and the northern road, from Nanyuki to Isiolo, Wajir and Bardera. Both were designed for use in dry weather, and to carry only the lightest of motor traffic. Before the war a motor convoy leaving Nanyuki for Wajir in the rainy season, a distance of 250 miles, would carry rations for three weeks, and might very well need them before it arrived. Work was started on these two roads as soon as war broke out, and by January, 1941, they were decently surfaced, though not metalled, as far respectively as the Tana, which was crossed by ferry, and as Wajir. Beyond these limits they were in enemy occupation, and it was unlikely that their standard, anywhere further on, would be superior to that which we had been able to reach.

Such was the terrain over which the opening phase of the campaign was fought.

* * *

The problem that confronted the "Q" Staff may be briefly stated as follows, The plan of operations contemplated the use of two Divisions to seize the town of Kismayu and the line of the River Juba. The administrative problem was to arrange to supply these formations, from railheads at Thika and Nanyuki, five hundred miles to the rear, with everything that they needed to enable them to live and to fight. This maintenance would only be required until such time as we had taken Kismayu; thereafter we could supply by sea to Kismayu from Mombasa, instead of by rail and road.

Supply from the Base Depots in Kenya as far as our railheads presented no difficulty. The Kenya and Uganda Railway could handle with ease the tonnages with which we had to deal, and the sidings and loading areas were sufficient. Railhead Commandants were installed, with representatives of the Services on their staffs, to unload, sort and stack the commodities arriving by rail from the Base Depots, and to despatch them forward by road as and when they were instructed.

In order to reduce the maintenance problem to more manageable proportions, and to cut down the 500 miles that separated the railhead at Thika from Kismayu, the first and obvious step was to build up an Advanced Base somewhere between the two. The only suitable place for this purpose was along the line of the River Tana, between Bura and Garissa, and a dumping programme was put in hand as soon as it was decided that the operation was to take place. Time was short, and although all M.T. that could be made available was put on the run between Thika and Garissa, it was not possible in the time to complete these forward dumps to the full quantities that we should have liked to have.

This seems a suitable point at which to give some account of the mechanical transport that we had at our disposal, and how it was employed. Mechanical transport was the key to the whole campaign, and the campaign was only possible because we had, thanks to the Union of South Africa, a quantity of M.T. very large in proportion to the size of the force that took part in the operation.

First line transport was on the normal scale for East African units. It carried all G.1098 stores and baggage, water for one day, and rations—at a pinch—for four days. It did *not* motorize the personnel, who had to march on foot unless extra transport was provided.

Second line transport consisted of Infantry Brigade Group Coys. and Divl. Troops Coys., serving the formations that their titles imply. They were designed to maintain their formations over a distance of sixty miles from railheads or roadheads in rear, and to carry all the commodities required—supplies, petrol, ammunition, etc.—except water. Their movements were controlled by H.Q.s. of Divisions.

Third line transport consisted of Reserve M.T. Coys., controlled by Force H.Q. At this time there were available between sixty and seventy R.M.T. Coys., each of 75 two-ton or three-ton lorries. About half of these Coys. were East African and, about half South African. The East African Coys. were equipped with Ford or Chevrolet lorries with ordinary box bodies, driven by African S. & T. drivers. The South African Coys. were equipped with Ford 3-ton troop-carrying lorries. These lorry-bodies, welded in one piece, had a seat along each side and a well between the seats. About a third of the South African Coys. were driven by white South African drivers of the Q. Services Corps : the other two-thirds by Cape coloured drivers, enlisted for this purpose in the Union. (The South African

1942.]

Coys. were actually double the strength of the East African Coys., but for the sake of simplicity the numbers have here been converted into terms of East African Coys.)

None of these third-line Coys. were permanently allotted to any special duty, but were kept as fluid as possible and detailed by Force H.Q. to meet the needs of the moment. It is worth while listing the principal duties for which third-line transport had to be detailed :--

- (1) For motorizing troops. It took three-and-a-half R.M.T. Coys. to motorize completely one Brigade Group.
- (2) For carrying water. One R.M.T. Coy. could carry about 30,000 galls.
- (3) For ordinary third-line maintenance; carrying supplies, petrol, ammunition and ordnance stores from railhead forward, and delivering to second-line transport.
- (4) For the demands of the Air Force, the Brigadier R.A., and the Chief Engineer.

Headings (1) (\bar{z}) and (3) are more fully dealt with in subsequent paragraphs, but heading (4) may well be elaborated here and not referred to again. Demands under heading (4) took up only a small proportion of the transport involved, but the trouble and exasperation that they caused was exceptional.

The Air Force had their own maintenance organization, and their demands for army transport were few. But the pace of the advance was so rapid that their maintenance transport was not always sufficient, and when help was wanted from us it invariably meant that, unless help was immediately forthcoming, there would be a breakdown. "Unless we can get 50,000 gallons of aviation spirit to such and such a landing ground by dawn tomorrow our aircraft won't be able to leave the ground. Can you provide the transport?" Demands of this kind had to be met, no matter what else suffered.

The B.R.A's demands for transport were also not large in quantity, but they were exceedingly troublesome. The B.R.A. is bound to be cautious and to demand that enough ammunition should be in reach of the guns to cover eventualities; but when transport is short, and the "Q" Staff are at their wits' end to know how to get up tomorrow's rations, they cannot help reflecting with some bitterness on the quantity of transport that is locked up carrying ammunition. Supplies and petrol, if not wanted by one unit, can be switched over to another. Even if they are offloaded and dumped at the roadside, they will sconer or later come in useful. But gun ammunition is of no value whatsoever except to the appropriate brand of gun, and once it has left railhead it can serve no purpose until that gun is reached, and it cannot be diverted or left behind.

And lastly the demands of the Chief Engineer. As most readers of this Journal are familiar with the problems of the Engineers during a campaign, it may be permissible to dwell a little on the problems set by the Engineers to the "Q" Staff. The Chief Engineer, like the B.R.A., has to guard against eventualities, such as an attacking force being suddenly thrown on the defensive, His consequent demand for transport for defence stores-barbed wire, pickets, cement, etc.-is such that the whole of the third-line transport available for all purposes would not meet it. Next comes his demand for lorries for carrying road-metal and labour for working on the roads. This can be looked upon as a good investment, saving wear and tear on transport, and as this kind of work never stops, a permanent or semi-permanent allotment of R.M.T. Coys. is probably the best answer. Last and worst are his demands for transport to move his pontoon bridges. "The bridge is being dismantled now, and must start tomorrow. It will take 120 lorries, and I'm afraid that they must be 3-ton Chevs. as nothing else will carry the pontoons, and as it's a difficult load the drivers ought to be white men." Somehow lorries and drivers are found, and the bridge goes forward. A week later "Q" enquires when X and Y R.M.T. Coys. which were detailed for this duty, will be back again. "X and Y R.M.T. Coys? Do you mean the Engineer Bridging Train?" There follows argument, and a forcible statement that this allotment of transport was not intended to be a permanent one. "All right, old boy, we'll let you have them back in a few days, but they may not be very much use to you. You see, we found the pontoons wouldn't ride properly so we had to modify the bodies a bit." And when the lorries finally come back they are found to have fitted on the chassis a timber cradle, admirably suited to carrying pontoons and completely useless for carrying anything else. (And should this meet the eye of Jerry Minnis, the writer hopes to be forgiven !)

Such was the composition of our third-line transport, and the principal duties that it had to carry out. During the formation of the Advanced Base on the River Tana, the bulk of it was employed on running between railhead at Thika and the dumps at Bura and Garissa; a small number of R.M.T. Coys. were allotted to the two Divisions to motorize a proportion of our troops on the far bank of the Tana, screening the Advanced Base; and none to carrying water, as distances from the river were all reasonably short. How this allotment was altered as the advance proceeded will be described later on.

Of all the problems to which answers had to be found, the most critical and the most difficult was that of water supply. Within our Advanced Base we could draw unlimited quantities from the Tana, which runs all through the year; but forward of the Tana there was no other source of supply until we should reach the River Juba, 250 miles further on. If we were lucky we might be able to obtain water at intermediate points by drilling, and drilling rigs were pushed up close behind our advanced troops, though the geologists were not hopeful. It happened in the event that water, brackish but drinkable, was struck at two places, Hagadera and Liboi, but our plans had to cater for the worst, and we had to reckon on carrying forward from the Tana all the water that we required.

The "ration" scale laid down was a gallon per man per day and half-a-gallon per radiator per day. A gallon a day does not go far in a hot climate, and it was realized that this scale could only be enforced for a short period. Thanks to the discovery of water at Hagadera and Liboi, and to the speed with which our forward troops made good the line of the River Juba, the period was only a few days for most of the troops engaged.

The first thing to decide was what form of transport should be used for watercarrying. The ideal would have been a fleet of water-tank lorries, but even had time allowed of their manufacture, it would have been too extravagant to employ vehicles which would be in use for a matter of only a week or two, and thereafter be of no value for any other transportation purpose. A relatively small number about a hundred—of such tankers were, however, sent to us from the Union in time for the operation, and were most valuable. Each consisted of a 450-gallon tank mounted on a Ford chassis, and each carried a petrol pump, and could pump itself full. It could discharge either through a single ventpipe, or through a length of piping fitted with twelve bibcocks. They were used mainly for distribution of water to unit first-line transport and the bulk carriage of water in large quantities had to be done by ordinary 3-ton lorries.

It has been mentioned earlier that the South African 3-ton Ford troop-carrying lorry had a scat running down each side of the body, and a well between the seats. During the process of much experimental work it was found that into this well there would fit ten 44-gallon petrol drums, stood on end and wedged together. Our first attempt to carry water in this way was unfortunate ; we used 44-gallon drums that had actually held petrol, and fondly supposed that any dregs of petrol would be removed by swilling the drums two or three times with water. It is worth remembering that once a drum has contained petrol it is virtually impossible to remove the taint, even by burning out the drum with red-hot ashes, and that any less drastic decontamination results in water carried in the drum becoming unfit for consumption. Luckily we learned this lesson in time, and Defence H.Q. at Pretoria sent us up tens of thousands of clean 44-gallon drums, specially marked and distinctively painted.

Eight South African R.M.T. Coys. were then selected for water transport duty, and as water was looked upon as the most vital of all commodities, the Coys. chosen were those with white South African drivers. This gave us a total of about a quarter of a million gallons of water on wheels, plus that carried in the tanker lorries, plus that carried in unit first-line transport. This water transport was not controlled by Force H.Q., but was allotted to Divisions in proportion to their strength and placed under control of Divisional Commanders.

Various difficulties arose over water provision, and to some we found satisfactory answers and to some we never really found answers at all. One was the filling of these big water convoys. An ordinary water-point is designed to provide continuously small quantities, reckoned in 24 hours' consumption, for units drawing from it. Such a water-point, even if it is not already working to capacity, cannot begin to compete with a water convoy that needs to fill say 50,000 gallons in three or four hours. There is no difficulty in designing and building water-points that can meet this demand, provided that the need for them is realized in time, and fortunately for us it was so realized. Another problem for which no general solution was found was that of distribution. A water convoy arrives in a Brigade area carrying a day's supply of water. The water is in 44-gallon drums in the bodies of the lorries ; it has to be transferred-somehow-into the unit's 2-gallon and 4-gallon tins and into the men's water-bottles. How is the transfer to be made ? It was, in fact, left to the ingenuity of each unit or formation, but their task was simplified by issuing extra quantities of 2-gallon and 4-gallon tins-100% in excess of normal scale and by providing as many as possible small semi-rotary pumps, lengths of rubber piping for use as siphons, and canvas tanks of various dimensions. Not much water was spilled or wasted in the process ; units had every inducement to see that it was not.

Water was only one of the commodities, although the most important, that had to be provided for the troops taking part in the operation. Having considered the water problem, and allotted the transport considered to be necessary, it remained to try to arrive at the tonnage of other commodities that must be provided daily, and the quantity of transport that would be needed to ensure arrival. Nor were such calculations simple.

Much the easiest figures to compute were those for rations. For a "field" scale of rations the weight is so much per man per day. By putting troops on a "hard" scale this can be reduced by about half, but only for a limited period. It makes little difference whether the troops are white or native, and the daily tonnage can be worked out by simple arithmetic.

The figures for petrol were another matter. An East African Brigade Group, fully motorized, contained about a thousand carburetters. On a day when the Brigade was stationary it would, in theory, consume no petrol at all. On a day when the whole Brigade Group was in movement it might consume up to 20,000 gallons.

Other items, for which a daily tonnage allowance had to be made were ammunition, R.E. Stores, Ordnance Stores, M.T. spares and E.F.I.; and something had to be taken up for "freak" demands. Some of these demands—e.g., that for ammunition—were bound to fluctuate wildly from day to day.

In order that it should be possible to calculate in advance whether we had enough transport to meet our maintenance commitment, it was essential that the "Q" Staff should take its courage in its hands and lay down a figure of what average daily tonnage would be required. The figure that was laid down and used as a basis of calculation was 50 tons a day for each Infantry Brigade Group and cach Divisional Troops Group. This figure proved to be on the low side,



Photo No. 1.-Typical bush in Tanaland.



Photo No. 2.--River Tana at Garissa.



Photo No. 3.-River Juba at Yonte.

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Transportation a bud joke, Photo No. 4. Main read, Dusty.



Transportation a bad joke. Photos Nos, 5 and 6 Main mail Minddy.



Photo No. 7. Lighters on the beach at Kismaya.

Q' in the East African campaign, 1941 - 4, 5, 6, 7

but it offered a reasonable basis of calculation and was used as such throughout the whole of the campaign.

Even after that figure had been laid down there was some more guesswork to be done before we could say whether we had enough transport to carry our maintenance requirements. We had agreed on the tonnages that had to be carried, but how many miles a day could we reckon on our transport covering ? We arrived at a mileage figure by bracketing " over " and " short." We reckoned that on a first-class road a lorry convoy could not average more than 150 miles running a day. This gave us a maximum. If, on the other hand, the road was so bad that a lorry convoy could not average 50 miles a day it ceased to be transportation and became a bad joke, and no calculation was possible. (See photos. 4, 5 and 6.) We accordingly assumed a figure of between 50 and 150 miles a day, depending upon what we knew of the road conditions, and in practice our ordinary working figure varied from 80 to 110 miles a day. Enemy interference from the air we did not need, mercifully, to take into consideration, for the South African Air Force virtually shot the Italian bombers out of the sky before our advance began.

One other aspect of the maintenance problem should be mentioned here. For any given operation, as outlined by the General Staff, "Q" can work out a maintenance project. The ordinary maintenance project covers the delivery daily, or at a stated interval, to the troops engaged, of the tonnages they require, and the project will show what quantity of transport will be needed to keep up this maintenance. But if the General Staff is prepared to put a time limit to the operation it may be possible for "Q" to produce an alternative maintenance project which will require much less transport. This alternative project will take the form of making the troops self-contained with all that they require for the stipulated period, and giving them the extra transport necessary, instead of arranging for a system of maintenance that will continue to function indefinitely. Which method is the more economical in transport will depend upon circumstances, and upon such considerations as to whether water has to be carried or not, and the mileage to be covered from the Base. But speaking very broadly, this method is worth considering for any operation that is intended to be concluded within a matter of ten days or so, and it was on such a basis that the advance from the Tana began.

The most anxious time for the "Q" Staff, during the whole campaign, was the fortnight that covered the final concentration of the two Divisions, their forward move from the Tana, and the occupation of Kismayu.

By that time the distribution of the R.M.T. Coys. had been drastically altered. Eight Coys. had been detailed for water transport duty, and had passed under Divisional control. Sixteen Coys. had been detailed for troop-carrying, and had also passed under Divisional control About fifteen Coys. remained available for third-line work from Thika forward. The big dumps at Bura and Garissa were by now completed, and it had been intended to use these fifteen Coys. entircly on working forward from Bura and Garissa and forming an advanced line of smaller dumps about a hundred miles towards the Juba. But although our Advanced Base on the Tana was in theory completed, it was found in practice that all sorts of demands constantly arose for stores which could only be obtained from the Base Depots in Kenya, and this meant that transport had to be taken from the fifteen Coys. to go back to railhead at Thika to collect them.

Every evening there was a conference at Garissa between the "Q" Staff and the representatives of Services, and the most important task of the conference was the determination of priorities and the allotment of transport. The things that had to be taken into consideration were; first, how much transport was available for allotment; second, what stores were awaiting transport from Thika forward to the Tana and their relative urgency; third, what stores were awaiting transport from the Tana forward again to an advanced dump. There was never enough transport to meet all demands, and priorities had to be laid down and strictly enforced. Petrol, supplies and ammunition were competing against each other, and against the stores that other Services urgently required forward. The item that soon came to the top of the priority list, quite unexpectedly, and tended to stay there, was M.T. spares. The roads were bad, and breakages—of springs in particular—frequent, and it was no use giving priority to any other commodity if the vehicles to carry that commodity were ineffective. In those early stages of the campaign R.M.T. Coys. were substantially up to strength in vehicles, but that happy state of affairs did not last long.

Under circumstances such as these it is inevitable that "Q" should take over certain functions that are usually discharged by S. & T. When the maintenance of a Force depends entirely upon road transport, the allotment of that transport must be in the hands of "Q". "Q" is, or should be, much more fully in the picture of operations than S. & T., and in a better position to judge what is essential and what is not, and to anticipate demands before they are made. It is for "Q" to say where the M.T. convoys shall go and what they shall carry; it is for S. & T. to ensure that "Q's" directions are carried out.

At one of these evening conferences it so happened that the amount of transport available for the following day was small—about 200 tons—and the claims for it were so evenly balanced that it was next to impossible to decide which was the strongest. We settled the matter by refusing all the claimants, and fetching up two hundred tons of N.A.A.F.I. stores, mostly beer. It was the most popular thing that "Q" ever did.

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The day came and the Divisions moved forward. This article does not profess to give any account of the operations, but five days later our advanced troops were established on the line of the River Juba, and had occupied Kismayu, which the Italians did not attempt to defend.

The administrative position was now entirely different. The business of carrying large quantities of water over long distances was finished, for we could draw water from the Juba, and could—and did—bring in water by sca to Kismayu and discharge it on shore. Also we could now switch over our main line of supply, abandon the road L. of C. from Thika forward, and maintain our troops by sea as far as Kismayu and thence by road.

Maintenance by road from Kismayu depended upon the existence of roads over which our M.T. could move, and the existence of the roads in southern Somalia was a precarious one. These roads were Italian built, and well graded. The majority were surfaced with " murram," a reddish-yellow sandstone which binds well enough to carry light traffic. The more important were thinly metalled, but there was no bottoming under the metal. The "murram" roads dropped to pieces under our advance, literally within 24 hours. In the morning one could drive a car over one of them at 40 miles an hour; driving back the same evening, after one of our motorized Brigades had passed that way, it was bottom gear and 10 miles an hour. The metalled roads lasted longer, but when they did collapse they were even worse than the others. Before we had been a week in Kismayu there were lengths of road near the town which had turned into deep troughs, with three feet of loose red dust in the bottom of them. Cars could not get through and either had to be towed by lorries, or had to turn off into the bush and try to make their way round. The latter was a hazardous adventure ; partly because driving blindly through the bush one might run into an ant-heap or into a tree that was rather too much for a car to take on; partly because the Italians had laid a certain number of land-mines in the bush, particularly in the vicinity of cross-roads. We should never have got as far as Kismayu, let alone beyond it, without the help of the South African Road Construction Coys. and Road Maintenance Coys. The feats they performed were astonishing ; dust, sand, mud, even lava, found them undismayed.

There was no alternative to making Kismayu our Advanced Base; the distance from Thika prohibited maintenance by road, and there was no other port on the coast. But as an Advanced Base Kismayu left almost everything to be desired. It had only one merit: that owing to the lie of the land the anchorage was always sheltered and could be used throughout the year, even during the monsoon which was shortly due to begin. There were two small jetties; but one of these had been put out of action by scuttling lighters alongside it, and the shore access to both of them lay across soft sand over which lorries could not even move empty, let alone load and turn. On the other side of this sand a single narrow road ran into the town, and after a series of right-angle turns forked, one branch going north to Afmadu, the other branch turning east to the Gobwein ferry across the Juba. These roads were surfaced, for the first three or four miles only, with lumps of coral.

The town of Kismayn had little to offer, even in the way of accommodation. There were a few shallow wells, but the water in them was brackish, and in ordinary times all the drinking water needed by the inhabitants was carried from the Juba at Gobwein, ten miles away. The power station and oil storage had been destroyed by the Italians before they abandoned the town, and everything of any value removed. A few of the buildings along the sea-front were built of stone, and useful for offices and for sleeping quarters.

As soon as it was known at Advanced Force H.Q. that Kismayu was in our hands, orders were sent to Mombasa to sail the convoy that was waiting there in readiness. This convoy had been loaded with large quantities of rations—on "hard" scale; petrol and oil; water—specially packed; R.E. stores; and ammunition. The water had been included to meet the possibility of Kismayu falling to us before we were able to draw water from the Juba, and it was deliberately loaded on top of the other cargo, as, if we did want it, we should want it very urgently. But by the time that the convoy reached Kismayu, we were drawing water all along the Juba, and it was exasperating to have to handle and discharge big quantities of water, of which we had little need, before we could get at the rest of the cargo which we wanted at the earliest possible moment.

In deciding how this water should be conveyed, it had been agreed that it ought to be in some portable form, requiring neither pumps nor tanks to handle it. It had therefore been packed at Mombasa in exactly the same way as petrol: two 4-gallon tins held in a wooden case. This was simple to arrange, as it was only necessary for the Mombasa petrol-packing plant to turn on water instead of petrol for a certain period of time. One of the mistakes we made is worth noting here. It was of great importance, for obvious reasons, to make these cases containing water immediately distinguishable from exactly similar cases containing petrol. Accordingly the cases had "WATER" stencilled on them in black, top and bottom. This made a clear distinction, but what we omitted to do was to mark the tins themselves, so once the case was opened, and probably thrown away, there was nothing to show what the tins contained.

The first lighters reached the beach on the morning of 19th February, (See photo. 7). They were a welcome sight, for stocks of all kinds were nearing exhaustion. The use of the jetties was quite impracticable in view of the absence of road access to them, and the lighters were brought up on the open beach immediately in front of the town. Here a tolerably good road ran along the sea-front, and it was possible to make a traffic circuit for lorries to pull in and pull out. In the first flush of triumph we thought that our troubles were over.

They were not. In the first place, discharging lighters on an open beach is a tricky business. If the lighter is put ashore on a rising tide she must be pushed or hauled up with the tide or she will float off again. If she is put ashore on a falling tide, and left high and dry, she cannot be taken off until the next tide, and that

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much of her time is wasted. Apart from this major trouble, manifold difficulties arose over tugs, stevedoring, and labour. In the second place, we were putting many hundreds of lorries a day over roads, either earth or coral, that had been designed for an occasional car or van, and they could not stand up to it.

On the morning of 20th February, the position in Kismayu could fairly be called desperate. The four big lighters were all on the beach, and the tug could not get them off. The Sca Transport Officer said that if he failed to get them off on that tide there was no hope of getting them off for a month. In the town itself the road had given way completely, and for several hundred yards there was a continuous line of lorries bellied and helpless, completely blocking the way to any other traffic in either direction.

It was a bad day. But the S.T.O. did get the lighters off, the Chief Engineer set about the road problem, personally taking charge of the working parties ; and slowly, slowly, stores began to arrive at the beach dumps with some degree of regularity and to be collected from the beach dumps also with some degree of regularity.

Meanwhile there was a lot of clearing up to be done outside Kismayu. The third-line transport was being re-grouped and moved forward, bringing up with it the remains of the dumps that had been formed on and forward of the Tana. These stray consignments coming in were of the greatest help in ekeing out the maintenance system through Kismayu, and again and again enabled us to meet some demand which otherwise would have been beyond our resources. The R.M.T. Coys. were by this time very much broken up and very widely dispersed, largely as the result of having to work northward to Dif and Wajir. (For the sake of simplifying this narrative no mention has been made of a South African Brigade Group which was brought into the operation from Wajir southward *via* Afmadu, and greatly complicated the supply and transport arrangements). Many of the R.M.T. Coys. indeed, did not succeed in collecting their scattered Sections until months afterwards.

One disconcerting factor in trying to get our new maintenance system going via Kismayu was the abnormal quantities of all commodities which units were anxious to draw. A fully motorized formation, even when in theory its vehicles are fully loaded, can and will find room for extra quantities of supplies, petrol, and other things which it knows it may want. At the beginning of the advance every unit was carrying a hidden reserve of this kind. As the advance progressed, this "sponge" was squeezed out until it was dry. When the unit found itself again in reach of a dump area, it wanted to draw not only the normal quantities for which the "Q" Staff had catered, but further quantities to fill the "sponge" to its capacity again.

But long before the development of Kismayu had reached a point which could be regarded as satisfactory, we had to switch our minds elsewhere. General Cunningham was already on the next map-sheet but three, and the development of Mogadiscio, three hundred miles ahead, as an Advanced Base was the subject to which he directed our attention.

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It will have been noticed that this article has confined itself strictly to the "Q" aspect of the operations, but the problems of the "A" Branch were almost equally difficult. To quote only two of them, there were the custody and evacuation of prisoners of war, in numbers such as we had never imagined; and the evacuation of our casualties, which mercifully were few. No attempt has here been made to draw lessons. Drawing lessons would be a tricky business, for the lessons depend almost inevitably upon conditions of environment and time and place, which in the nature of things will never recur. The most that can be claimed is that this story of how the thing worked out in practice does touch on many of the matters that must be considered in any operation of the kind, and, even if it does not offer hard-and-fast solutions to the problems, may at least indicate what those problems are.



HINTS FROM HISTORY.

(PART II.)

The Supply of Engineer Stores and Equipment.

By BRIGADIER-GENERAL W. BAKER BROWN, C.B.

In the first part of this article which appeared in *The R.E. Journal* for June, 1942, the story of the supply of R.E. Stores in France is carried up to the middle of 1915 and includes the formation of the staff of the E.-in-C. office and of the D. Works in France.

In August, 1915, the D. Works brought Major H. G. K. Wait into his office as an additional Staff Officer for store duties. Wait had had considerable experience of store work as Inspector R.E. Stores at Woolwich and Instructor of Electricity at the S.M.E. and member of the R.E. Committee. His appointment was the beginning of the separate store staff, though Stuart still remained the head and personally dealt with all papers.

All this time the French Railways had been insistent that as far as possible stores should be loaded at the ports direct into the trucks in which they were to be carried to the front. This was very difficult to arrange, especially with R.E. Stores, as there is always a time-lag between the placing of an order and the delivery of the goods, which is seldom less than three months and may be much longer. It is impossible to foresee requirements so far ahead and most difficult to arrange to obtain the stores and pack them on board ship so that, when unloaded, they can be sent direct to a particular destination. But by obtaining in advance copies of the shipping invoice and with a continual intercourse on the telephone with the Naval Transport Officer and the officers in charge of stores at the ports, Wait was able to carry out the instructions of the French to a remarkable extent.

But in every cargo, there were stores not immediately required which could not be left on the wharfs and as early as February, 1915, the Director of Works arranged store-yards at Havre and Boulogne and also a yard at Abancourt, where a big group of depots for supply and other services was being formed close to the large regulating station at Romescamp; this yard received stores from Dieppe, Fécamp and Rouen.

On the northern line the wharfs at Boulogne used for R.E. Stores were handed back to the French in August, 1915, and Dunkirk was substituted as a Base Port. The centre of the store movement on the northern L. of C. was then shifted to Calais where Major J. W. S. Sewell, who had arrived in May, 1915, in command of the 1st Coy., was in charge. In September, 1915, he formed a storeyard at Les Attaques which had access both to the Nord railway and to the canal, by which stores could be transported to the two northern Armies, the IInd and Ist. This yard was fitted with a triage for sorting trains. The area first used was about 50 acres, which was enlarged to 62 acres by the end of 1916. The 1st Coy, was raised to the establishment of a Base Park Coy, in 1916 and a workshop was formed at Les Attaques in January, 1916, mainly for wood-work. The work at Dunkirk was in charge of a detachment of the 1st Coy, but remained under Sewell's control. Sewell was graded as Chief R.E. Stores Officer (N) in 1916. On the south line the various stores officers reported direct to Wait but they were also required to do store work and arrange the transport of stores for the A.D.W. of the area. In 1916 Lieut. Col. C.L. Spencer of the Territorial R.E. was appointed Chief R.E. Stores Officer (S) with an office at Rouen, but he was mainly an Inspecting Officer reporting to the D. Works. In the autumn of 1916 the increase in the numbers of the Armies caused an overstrain on the Railways and all Supply branches on the L. of C. and on the re-

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commendation of Sir Eric Geddes a Director-General of Transportation was formed to take over all the Railway Transport and also other branches, including the construction and maintenance of Roads and all work at the Ports. This involved the surrender of most of the R.E. depots on wharfs and also stopped the attempt to load stores at ports direct for destination. All stores landed were now despatched by local trains to the base depots, where they were unloaded and stacked for despatch by trains to the front. Les Attaques was already working on this system but on the Southern line the change involved many alterations at store depots.

At this time too, the War Office were asking that the number of officers in France who were authorized to demand Engineer Stores on the War Office should be reduced and that all such demands should come through one central authority and by the end of 1916 a reorganization was approved under which the Engineer-in-Chief was made responsible for all Engineer services in France, including the work done by the Chief Engineers of Armies at the front and the D. Works on the L. of C. An enlargement was approved of his staff under which Colonel W. A. Liddell became Deputy E.-in-C. with the rank of Brig.-General and Major C. C. H. Hogg was made Assistant E.-in-C. with the rank of Lieut.-Colonel. These officers took general control of works services in Army areas, a control which was exercised mainly by a rationing of the amount and kind of Engineer Stores to be sent up monthly from base depots. It was also decided to enlarge the staff of the D. Works for dealing with stores and a senior officer was sent out as an additional Deputy Director Works for this duty. The officer selected was the writer of this article, who had had considerable experience of store work as a member of the R.E. Committee and Inspector of Electric Lights at the War Office. In addition the D.F.W. arranged to release Major R. H. Lewis for duty in France. Lewis was a trained Machinery Officer and had been Assistant Inspector of R.E. Stores at Woolwich; on the outbreak of war in 1914 he was serving at the War Office as Secretary R.E. Committee and in charge of the branch which dealt with equipment questions.

When the final approval of the new organization was received in February, 1917, the new D.D.W. was put in charge of all store questions and arrangements were made to extend and improve the existing organization. The weak point at the moment was the work on the Southern L. of C.; the work had increased considerably with the formation of the IIIrd and IVth Armies and the extension of the British line southwards. Lewis on arrival was made C.R.E.S.O. (S) (in place of Lieut.-Colonel Spencer, who was made C.R.E. of an area) with instructions to make his headquarters at Abancourt with also the shops and store-yards at Havre, Rouen, Dicppe and Fécamp under his orders. For personnel, Lewis was allotted the 24th Coy. which though a Base Park Coy. had been working under the C.R.E. Boulogne. A few months previously, a Store Section of 3 officers and 100 men had been added to cach Base Park company to provide a trained nucleus for the supervision of the labour units who came to work daily in the store-yards. This scheme worked so well that at the end of 1916 a second section was approved for each Base Park Company, so that Lewis now had at his disposal two Base Park companies-the 24th and 32nd and four Store Sections. An officer of the rank of Major was allotted as Second in Command and in charge of the depot at Abancourt, and additional officers on the general list were added on both lines until the total officers on the Northern line reached about 35, while on the Southern line, which had about three-fifths of the whole store work, the number was 50.

The removal of the depots on the wharfs necessitated an increase in the storeyards. The original depot at Havre had been developing very well under Major A. V. T. Robinson (now Wakeley) who had had 1,200 men under his orders daily and was also instructing in bridgework detachments of officers and N.C.O's sent down from the R.E. companies at the front. The yard now covered about 30 acres but was rather congested and owing to marshy ground could not be further extended; it was therefore decided to move the woodworking machinery with the left half of the 32nd Company to Rouen, leaving room at Havre for an extension of the bridging stock. There was also at Soquence, a short distance up the river, a yard of about 12 acres, which had been constructed by the Transportation Directorate for landing stores by barges to relieve the main wharfs.

At Rouen a timber yard, which had been formed earlier in the war with Captain Kenworthy in charge, was now enlarged to about 12 acres to take the new workshop, and a new hutment was constructed for the half company. There was also a yard on the river just below Rouen at a place called Quevilly where a space of about 20 acres with a pierhad been allotted to the R.E., the remainder being in the charge of the A.O.D. This could also receive stores sent up by barge. To free the store officers for their special duties, arrangements were made to give the C.R.E.s, at Havre and Rouen a store-yard of their own with a small workshop under a Quartermaster for their local work and the Base shops were instructed not to undertake any work for local officers which would interfere with work for the Armies.

The yard at Abancourt had by this time reached a size of 32 acres and was in the charge of a Quartermaster R.E. In the middle of 1916 it had been cleared and handed over to the A.O.D. for storage of ammunition but was given back to the R.E. two months later. Lewis now arranged for an extension to about 150 acres with suitable sheds for small stores and a large workshop for woodwork. A new hutment was built for the 500 men under him. The ground was not quite level and the sidings were laid on the comb system, there was no *triage*, all trucks when loaded being moved to the Romescamp sorting yard, which was also used for Supply and Ordnance trains.

Under the old system of working, the stock in the store-yards was always small and at the beginning of 1917, the total stock of the principal stores required by the Armies had fallen to 5,000 tons, while the monthly demand was about 90,000. So the next step was to increase the stock so that at the beginning of each month there should be at least one month's supply of each store likely to be required, in addition to a considerable margin in the corps dumps at the front. This was very necessary, as the R.E. could never rely on a steady movement of stores when active operations were in progress and the movement of ammunition was given precedence. The building-up of the stock was much helped by a long and heavy frost in February, 1917, during which nearly all movement by rail and road was suspended, but the movement by sea continued, so that stores accumulated in France. During the early months of each year the amounts sent to the front were below the average until, towards the autumn, demands for hutting stores increased the total. By keeping the average monthly receipts at about 100,000 tons, a good stock was gradually accumulated.

In February, 1917, the British line was extended 20 miles to the south and at the end of the month the Germans withdrew to the Hindenberg line, followed by the HIrd and IVth Armies. As soon as the Railways could be extended, new corps dumps were formed and had to be filled. So for several weeks, trains of R.E. Stores were sent to the front to the number of 16 or 17 a day. The usual "train " contained fifty 10-ton trucks, but because of the bulk of some R.E. Stores only an average of 350 tons could be carried in each train.

At the end of March an important change in the supply of timber was made by the formation of the Directorate of Forestry under Brig.-General Lord Lovat. From 1915 the D. Works had been cutting timber in some of the French forests which were under Government control and had also placed contracts at Bordeaux. A total of about 25,000 tons a month was obtained in this way, but much more was required by the Armies, while the supply of timber from Canada was restricted by shortage of shipping and the activity of hostile submarines. Pressure was therefore put on the French Government and the War Office arranged the special Directorate to exploit more French forests. A further gain was that Lord Lovat was able to obtain men from Canada and a supply of saws and plant on a scale which had been denied to the Director of Works. After discussion it was arranged that the supplies from the forests should take the form of halfround timber for sizes up to 9-inch diameter and sawn slabs of thicknesses from 3-inch to 3 inches from trees of larger diameter; the outside of the cut logs to be used as firewood or dunnage to form bases for stacks of stores. The half-round and cut timber was to be distributed between the R.E. Stores and the Transportation Directorates, who would arrange to work the timber into any form required. This arrangement proved successful and by the end of 1917, the supply of timber to R.E. yards reached a total of 75,000 tons a month. As this supply increased timber from overseas was reduced until only about 10,000 tons of British timber was sent over monthly, mostly by barge from Richborough to Calais. In addition, full use was made of French and British contractors in France for the supply of manufactured articles. One British contractor who was domiciled in Paris took a contract for one million trench boards which he distributed in small lots of about 20,000 each to French sub-contractors in the centre of France. About May, Brady suggested that the woodwork for the 20,000 Nissen huts on order should be made up in France and a little later, an order for 15,000 tent bottoms for the A.O.D. was passed for execution, followed by many other wooden articles such as tables, or forms. All this work required a considerable extension of the Base Workshops. In addition to the shops at Havre and Rouen, Lewis organized a large shop for woodwork at Abancourt, collecting saws and other tools from various sources until there were nearly 50 saws at work on the Southern line. While the south was expanding in this way, an extension was started in the north at Vendroux, near Les Attaques, increasing the store-yard to a total of 150 acres. The site was nearly flat and the yard was laid out on the gridiron pattern with a large triage. The work of construction took six months. The new workshops included an up-to-date metal shop with cupola for iron castings and a number of smith's hearths and machine tools, also a large addition to the woodworking machinery to a total of about 35 saws. In connection with this, Sewell organized a workshop company of German prisoners who were glad to work at their trades and this proved so successful that similar companies were formed at Abancourt, Rouen and Havre.

The production of wood in France reduced the total of R.E. Stores landed at the ports to about 40,000 tons a month.

Meanwhile the E.-in-C's, office had been getting control of the store demands on the War Office, and a system was gradually built up under which Lieut.-Colonel Hogg was able to prepare a monthly demand to include all ordinary stores for the Armies and L. of C. The details for the L. of C. were collected by the D.D.W. (Stores). These demands were sent in about 3 months ahead to allow for the time-lag in supply. Special large orders were still sent in by the E.-in-C. for such items as pumping plant or machinery which could not be dealt with on a monthly basis and on the L, of C, such items as the steel framework for the new sheds at Vendroux were supplied through special contractors in England, usually on a basis of "supply and erect," so these items did not pass through the R.E. Store depots. During 1917, there were a series of operations at the front which did not much affect the R.E. Stores until the fighting began at Paschaendale, when an exceptionally wet August and the nature of the ground caused an abnormal demand for trench boards, and during this month a total of 350,000 trench boards was sent to the front, almost exhausting the stock on both lines; this number would form a pathway two feet wide for a distance of 400 miles | The total of R.E. Stores which passed through the yards in August reached 140,000 tons and this monthly figure was nearly maintained up to the German advance in March, 1918.

About May, 1917, a new duty had been put on the Stores branch by a decision

that all tents and hospital marquees on the L. of C. should be replaced by huts. Up to this time huts were only allowed for the administrative centres and men in the depots were living in tents, or their equivalent, with hutted accessories. Of 395,000 British troops on the L. of C. only 125,000 were in huts, so that accommodation had to be provided for 250,000 men, while of about 62,000 hospital beds, 42,000 were in marquees. To provide huts, Lieut-Colonel C. W. Davy at Paris approached the French authorities and after much discussion, 1,500 large Adrian huts each 100 ft.x 26 ft. were obtained to accommodate 70,000 men and 20,000 hospital beds. These came into Abancourt for distribution all through 1917 and 1918. Davy also obtained 1,300 small huts from Swiss contractors. Many others were manufactured in the C.R.E. shops and later in Base shops.

When first formed, the Transportation Directorates had helped a good deal in enlarging the store-yards and improving the train movements, but as the Armics increased they began to feel the pinch and to curtail facilities for moving R.E. Stores. The first cut was the closing of the port of Fécamp which had been specially organized for R.E. Stores and was well suited for handling the traffic from the London Docks. This was a great loss and by throwing more traffic on Havre and Rouen increased the congestion at these ports. Then complaints were made that the cross-river movements at Rouen were difficult, as the railway bridge constituted a bottle neck, and that the yards at Soquence also involved a crosstrain movement. Lewis and his next senior attended the daily railway conference at Abancourt to look after R.E. interests, and he partly met the difficulty by storing at Soquence any stores which were in excess of immediate requirements. This was important when salvage began to arrive from the front ; this had been organized under a separate Directorate about September, 1917, but the salvage staff acted with more zeal than discretion and salvaged everything they could find, including much rough timber and such items as damaged corrugated sheets which could not be used again without overhaul. Two more Store Sections were added to the R.E. Stores personnel to deal with the R.E. salvage and good work was done by a Section under Captain Porter, who was sent up to clear abandoned dumps behind the III and IV Armies. Among other finds was a complete Corps Dump under a Quartermaster R.E., which contained about 20,000 tons, not only of special R.E. Stores, but of entrenching tools, barbed wire and sandbags. To move such a dump meant more handling in the Army area, so it was always easier for an Army to obtain a new supply by train from the base, rather than to shift an existing dump. Besides this, Porter was employed for about six months. clearing up the remains of several Corps Dumps, making up timber salvaged into trench boards and other articles and sending the surplus back to Soquence. On the northern line where the distances were smaller, salvage as collected was sent back to the new yard at Vendroux where it was " digested " at leisure.

The movement of British troops to Italy in November, 1917, caused a demand for R.E. Stores to be sent from Abancourt and Lewis had at the same time to detach a half Base Park company and a Store Section for work in Italy. The train movement proved difficult and only about 2 or 3 trains of R.E. Stores a week could be got through, the amounts dispatched being controlled by the E.-in-C's. Office. The Stores branch also lost the services of Lieut.-Colonel H. G. K. Wait, who was sent to Italy in charge of R.E. Stores for that Command; he was accompanied by Captain Kenworthy who had done good work at Rouen.

At the end of 1917, there was a certain amount of friction between the British Government and the Command in France, mainly due to the operations at Paschaendale, also there began one of the periodic changes among the senior officers, which are intended to prevent staleness and to provide promotion for junior officers. Among the senior officers to be moved was the Engineer-in-Chief. Major-General Spring Rice, while Brig.-General W. Liddell was promoted Major-General and appointed Chief Engineer of the III Army. Their successors at Headquarters were Major-General G. M. Heath and Brig.-General E. P.

Brooker. At the same time there was an agitation at Home for a Civilian Minister of Supply and a proposition was put forward that a leading Civil Engineer should be appointed to take charge of all the Engineer work in France, with a civilian in charge of R.E. Stores. These latter proposals were negatived, mainly because they were not supported by the leading civilian Institutions of Engineers who had been working in close touch with Maj.-General Scott-Moncrieff at the War Office during the whole war. When the Civilian Supply Minister, Mr. Andrew Weir, was appointed, he asked a leading Civilian Engineer, Mr. J. Peters, who was his Engineer adviser, to report on the supply of Engineer stores. Mr. Peters inspected in considerable detail the large establishments which had been built up by Lieut.-Colonel Oakes at Adastral House and also came over to France and inspected the store-yards and work there. In the result he reported that he found the whole business was being admirably done and he could not suggest any alteration or improvement, and on this report the R.E. were allowed to continue their own system of supply to the end of the war, the only branch of the Army which was so treated.

As the new yard at Vendroux approached completion, half of the stock of bridges at Havre was moved forward to the new yard and also some of the spare parts of machinery. Les Attaques had from the beginning been in charge of the mining stores and Sewell now took over from the II Army a brickworks this Army had started in its area. This produced in all about one million bricks. He also took charge of a concrete block factory from the same Army which was manufacturing concrete pillboxes. The advances by the Germans in March and April drove all Armies, first the V and III and then the I and II, off their trenches and behind their Corps dumps, which fell into enemy hands. At one time, there was a threat to cut the L. of C. into two parts, and the E.-in-C. asked for the services of Sewell to help the work at G.H.Q. so that till the end of April Sewell administered the northern line direct from headquarters. Temporary intermediate dumps were opened, at Hesdin for the north and at Abbeville for the south, from which troops could get small supplies of R.E. Stores by road transport. The train movement was reversed and trains of machinery and stores saved from the front were sent back into the R.E. Stores depots. When the German advance was stopped, the Armies wished to resume their previous independence and to reopen their own workshops. It was however, considered better to extend the Base shops, so one of the Army workshops companies with an Area Employment company was sent to Les Attaques and a similar group to Abancourt. At the former, Sewell absorbed the newcomers into his new shops, but at Abancourt Lewis arranged a further extension of his yard to a total of 162 acres and erected an additional workshop and hutment for the extra company. The reduction of the Armies' workshops transferred to the Base shops a good deal of work formerly done by the Armies and the consumption of timber in the shops of each line soon exceeded 6,000 tons a month.

In April, 1918, there were more changes among the senior officers, Lieut.-General R. C. Maxwell, the Q.M.G., was sent home and succeeded by Major-General Travers Clarke. This officer had been in France for some time reporting on the H.Q. organization. He was an advocate for a Civilian as head of the Engineering work and when this was negatived, he asked that the Director of Works should be under his orders and not under the E.-in-C. and that a separate Directorate of Engineer Stores should be formed, also reporting direct to the Q.M.G. A proposal to form a Directorate of Engineer Stores had been made by Brig.-General W. Liddell at a conference of C.E.s. of Armies in June, 1917, but was negatived as the C.E.s. were not then prepared to surrender any of their independence. The system which had been built up between the E.-in-C's. staff and the D.D.W. (Stores) during 1917 answered all practical requirements and it is not easy to see what the Q.M.G. expected to gain by the change. All the stores questions were now working smoothly, there were sufficient store-yards

and base shops, the yards were full of stores, the shops were full of work, and if the Armies did not always get as many stores as they asked for, they got as many as they could use, and every ton that the railways and canals could carry to the front. The initiation of any large project involving Engineer work necessarily involves the previous concurrence of the General Staff and the Q.M.G., but once approval has been given, the only duty of the Stores Staff is to supply the necessary material as quickly and efficiently as possible.

The D. Works was placed directly under the Q.M.G. from April, but the Stores work continued under the D.D.W. (Stores) until the end of June when it was decided that youth should carry the day and Lieut.-Colonel Sewell was appointed Director of Engineer Stores with the rank of Brigadier-General, the writer after a few weeks' employment as a D.D.W. for Works, being appointed Chief Engineer in Ireland at the beginning of September.

During this interim period the work on the Southern L. of C. was adversely affected by German attacks from the air. Such attacks had been attempted for some months past, Les Attaques having some months' experience of bombing. But in May the Germans made a determined attack on Abbeville and pushed as far south as Rouen. For some weeks the staff of the Director of Works had to sleepout of the town to avoid the attacks by night and in the middle of Mayan attack on Abancourt set fire to the Ammunition Depot. The R.E. store depot was only slightly damaged but the side of the officers Mess was blown in and there were numerous casualties among the R.E. including seven of Lewis' staff who were killed by a raider. The Chinese labour was scattered over the countryside and the Railway yard was entirely disorganized.

The formation of the new Directorate caused some changes of personnel; at General Headquarters the work formerly done by Hogg was taken over by Sewell and Hogg joined one of the Armies at the front. At Abancourt, Lewis who had been overworking for some time, was sent home by a Medical Board and was replaced by Lieut.-Colonel J. G. Fleming. In addition to the work at Headquarters, the Director of Engineer Stores took over the responsibility for the forward dumps and, at the end of June, Sewell sent Capt. and Qr.-Mr. F. J. Cutting to reorganize a number of them. Cutting had joined the Stores branch in January, 1915, in charge of the store movements at Boulogne; he moved to Les Attaques in August that year and had done excellent work in the development of that yard. In August, 1918, Sir Douglas Haig began the series of advances which led to the end of the war in November and during these operations the demands for Engineer Stores fell off. In September the Transportation Directorate said they were unable to move R.E. Stores from Havre and Rouen, so that the stocks there, which were fortunately not important, were immobilized. But the workshops at Rouen had to be moved to Abancourt.

As the Armics moved forward the stocks of bridges were drawn on and sent up to the front and by the Armistice over 300 steel bridges and as many smaller ones had been constructed in France and Belgium, a satisfactory end to a good piece of organization. The Armistice naturally brought to an end the movement of Engineer stores for trench warfare, but huts and hutting materials were in increased demand to provide accommodation at ports for the embarkation of troops, so that all the Base shops continued in full work till the end of March, 1919.

On 1st July, 1918, the numbers employed by the Stores Directorate totalled 108 officers and between 3,000 and 4,000 men while about 10,000 men, from labour units came into the yards for work daily.

To complete this story of a successful organization a further reference is necessary to the buying branches at the War Office, who were of course working for many theatres of war, the Dardanelles, Egypt, Mesopotamia, Salonika, with East and West Africa. These branches were known as F.W.5, F.W.8 and F.W.9. The work of F.W.5 under Lieut.-Colonel D. Brady has been referred to in the above account. This branch was formed as a representative of the D. Works in France, but the procedure which developed proved so satisfactory that the Engineers-in-Chief of other Expeditionary Forces used its services. Brady provided personnel—officers and staff—for Engineer Services, and acted as an intermediary for the supply of all classes of Engineer Stores and timber, distributing orders to the supply organizations concerned. When the Canadian Forestry Corps was formed most of the work in the War Office fell to Brady and he also helped in getting technical assistance on such questions as geological information, well and pump sinking, special machinery, camouflage and the system of water supply for Palestine. Brady had a smallstaff, mostly composed of ladics, and some clerks.

F.W.8 was the Machinery Branch of the War Office and, in addition to the purchase and inspection of all steel work and works stores, carried out work for the Railway branches, but this stopped when the Transportation Directorate was formed in December, 1916. The branch also advised on details and arranged supply of vehicles and machinery for the workshops of the Royal Flying Corps and this continued to the end of the war, after the Royal Air Force had been made a separate body in April, 1918. In August, 1914, the branch was in the charge of Capt. R. Oakes, the Inspector of Iron Structures, with a staff on mobilization of two Staff Captains, two Quartermasters and twenty-four. other ranks. This was considered sufficient for the original Expeditionary Force of six Divisions but, as demands accumulated, the work and the staff rapidly expanded until in 1st April, 1917, Oakes, now a Lieut.-Colonel, succeeded in moving his organization into Adastral House, near Blackfriars Bridge, the status of the head of the branch being raised to that of Assistant Director with the title of Chief Mechanical Engineer. In August, 1917, Oakes was sent to Mesopotamia for important Railway work and was succeeded by Colonel S. L. Craster who was in charge till the end of the war when the staff at Adastral House numbered 49 officers and 143 clerks and draughtsmen, while the staff of outside inspectors, who in peace numbered three, had grown to a total of 74. There was also the staff under Lt.-Col. A. N. Tucker at the London Docks. In 1918, the status of the head of the branch was raised to that of a Deputy Director.

In addition to the shipping branch, which at one time employed a fleet of 22 vessels, Oakes started an experimental yard at Claygate where trials took place of tunnelling machines, pipe pushers, trench diggers and light and heavy ropeways. The branch also supplied the 2 ft 6 in. gauge railway for siege warfare which found its final use in Palestine and designed the sectional steel bridges for France; special plant included laundry machinery, machine tools for R.E. workshops, fire engines, destructors, disinfectors, cranes, concrete mixers, deep well boring plant, pumps of many descriptions and water purifying plant. Much machinery, including baking plant to provide 11 million bread rations a day, was supplied for the American Army; Mesopotamia asked for spare parts for hundreds of pumps of English manufacture seized in the country; the Dunster Force asked for a monocable roadway for mountainous country, while Palestine in April, 1918, demanded a special roadbridge to cross the Jordan, 240 ft. overall, which was supplied and erected in September. But perhaps the largest scheme was the supply of 10-12 inch water piping and four complete pumping installations to carry water from Egypt to Palestine across the desert, a distance of 87 miles; the order was received in July, 1916, and the work was completed by February, 1917. The branch continued to function and to supply stores up to 1st July, 1919, when the supply side was handed over to the Ministry of Munitions, and the organization merged into a new Electrical and Mechanical branch under the D.F.W.

The branch which became F.W.9 was in August, 1914, in the charge of Major A. H. Dumaresq, the Inspector of Electric Lights, with a staff of two officers and six subordinates; this was increased by the beginning of 1919 to 12 officers and 34 subordinates. In May, 1917, Dumaresq died in his office and was succeeded by Lieut.-Colonel E. C. Seaman who had held the appointment of I.E.L. 1908-1912. Lieut.-Colonel Seaman died in May, 1919. This branch was responsible for all Vocabulary Stores and also for all Electrical services including Signalling. The latter service has not been previously referred to in these notes, but it remained a branch of the R.E. though in all our Expeditionary Forces a Director of Signalling was appointed who made his own arrangement for the custody and issue of stores and equipment. Included under Signalling was Wireless Telegraphy which was only in its infancy in 1914. This side of the work grew so much that in 1916 a "Signals Experimental Establishment" was established on Woolwich Common which employed 17 officers and 267 others. The first wireless apparatus for communication with aeroplanes was developed by F.W.9.

In addition to wireless, the work of the Chief Inspector of R.E. Stores at Woolwich, who worked under F.W.9, increased enormously, the value of stores passing through his hands reaching 32 million pounds. The officer in charge in August, 1914, was Capt. F.W. Robertson and he had a staff on mobilization of 4 officers and 165 subordinates; this increased to a total of 30 officers and 1,620 subordinates in October, 1918. Among other items which will give some idea of the mass of work carried out was the supply of 1,300 million sandbags with ten million posts for wire entanglement and the same number of screw posts, also such items as 233,000 miners' hammers and 235,000 picks and shovels. The total bridging equipment for the original Expeditionary Force included 108 pontoons; this was increased to nearly 3,000. Searchlights for anti-aircraft defence, a new demand, reached 620 in 1916, and the following year, 100 fixed and 100 mobile sets were sent to France, and an order was placed for 800 sets with five-foot projector, but only about 125 had been supplied by the end of the war.

For Signal Stores, the Post Office acted as a contractor and supplied among other items 100,000 sets of telephone and telegraph apparatus, 53,000 miles of cable and 13,000 tons of line wire. Stores supplied through C.I.R.E.S. Woolwich included 11,000 telegraph sets, 120,000 telephone sets, 100,000 signalling lamps, with 600,000 miles of telephone cable.

In July, 1915, the demands received were in excess of the capacity of the trade, so a small factory at Soho was taken over; three more factories in the London area were taken soon after and other establishments were added. The whole was placed under a Manager reporting direct to F.W.9, until in 1918 the expenditure reached one million pounds a year with an output of 1,000 instruments a week. F.W.9 had been responsible for the supply of all wireless apparatus for the Flying Corps and this continued to the end of the war.

The status of the head of the branch was raised to that of Assistant Director in 1917, with the title of Chief Electrical Engineer, and the status was again raised to Deputy Director in 1918.

On the death of Lieut.-Colonel Seaman, Lieut.-Colonel H. G. K. Wait was appointed Assistant D.F.W. at the War Office in charge of F.W.9 and in September 1919, he also took over the control of F.W.8, thus becoming the head of the Electrical and Mechanical branch at the War Office; an organization which has continued to the present day.

CANADIAN-BUILT AERODROME IN BRITAIN.

Just over four months ago men of the Royal Canadian Engineers stationed in this country began on a large expanse of woodland and scrub "somewhere in England" the construction of an aerodrome for the Royal Canadian Air Force. Yesterday the completed aerodrome, with its vast concrete runways, was handed over to the R.C.A.F. by General Sir A. NcNaughton, C. in-C. of the Canadian forces in Great Britain, who said that, if necessary, the aerodrome could have been put into use within three months from the day that the work was begun.

(The Times, 17th October, 1942.)

AN IMPROVISED BRIDGE.

By MAJOR A. E. COCKERTON, R.E.

THE following is a description of a two-pinned arch rib bridge of 47 feet 6 inches span constructed and erected by two sub-sections of a Field Company as a training exercise in improvised bridging. The time taken was 18 hours.

It was the third of three bridges improvised and constructed by the company during their training. The first being a suspension bridge of 160 feet clear span and the second a Warren Truss bridge of 40 feet span.

It was found that the men were particularly keen on improvised bridging and displayed considerable ingenuity in the work which by reason of its novelty afforded a welcome variation to the normal training.

Apart from the G.1098 equipment of the Company the following stores were available :---

No. 100 F.B.W. Mk.II chesses. 12 Steel cribs. 25 $12^{\circ} \times 9^{\circ} \times 4^{\circ}$ Planks. Quantity of lashings, etc. 20 Sleepers.

As in all improvised bridging schemes, the material available was the starting point for the design, at all points the theoretically best solution had to be modified to suit the materials available.

The detailed calculations were made by Lieutenant A. J. Harris, B.Sc., R.E. commanding No.1 Section, who built the bridge.

CONSTRUCTION OF RIB.

The key point in the construction of the rib is by the employment of the chesses breaking joint, to give resistance against bending. This entailed drilling holes in the centre of the outer chesses to take the connection from the centre chesses.

These holes required positioning and drilling with extreme accuracy. A few holes drilled an eighth of an inch out of position necessitated the rejection of the chesses.

The connections were made with Ordnance Holdfast pins thrust through the holes at the ends of the chesses. These pins were amply strong in shear being in every case in double shear.

Some doubt was felt as to the bearing strength of the timber around the holes, but as the chesses were of best hardwood, many being of Lignum Vitae, and previous experience in the construction of the Warren Truss had shown that the chesses could be stressed to their safe load capacity without deformation, it was decided to assume the connections could develop the full strength of the chess.

The completed rib weighed approximately I ton and was handled fairly easily by 20 men. It was erected on the bank, not flat on the ground, but on its back with the concavity upwards—construction starting at the middle and working outwards at both ends at the same time. On completion the feet of the truss were strained together with tackle and held. This prevented overstraining during erection and ensured that on release of the tackle, when placing the ribs on the bankseats, there should be full contact with the abutments.

The ribs were successfully manhandled over the gap with the help of skids down the bank, and were then erected and guyed up ready for the decking.

The spaces between the chesses were packed out at regular intervals with timber distance pieces and lashed around. This with the rigidity given by the roadbearers was considered sufficient to provide for lateral rigidity.



ABUTMENTS.

Two abutment designs were adopted. One composed of sleepers bedded normally to the thrust of the rib and the other composed of sleepers laid flat and wedged against a vertical earth face behind.

It was found the first type was difficult to set out and construct accurately and had no advantage over the second which could carry a steel crib pier to support the decking and shore span. The load of this pier added a vertical component to the rib thrust, thus increasing the stability of the abutment.

DECKING.

The decking was constructed with $9'' \times 4''$ roadbearers carried on transoms built up of two $9'' \times 4''$ planks with 4'' distance pieces. The length of the planks available for roadbearers resulted in three load points on the rib. Had shorter timbers been available, the concentration of load and high bending moment stresses would have been avoided.

There were, unfortunately, insufficient materials to deck the bridge completely and sleepers were laid on the last bay to equalise the dead load.

As soon as the transoms were placed and lashed, bracing, consisting of 8 strands of 1 inch S.W.R. was fitted. This ran diagonally from the springing of one rib to the first transom of the other and was windlassed tight by a park picket.

CALCULATIONS.

It was assumed that the rib was a perfect segment of a circle of uniform section and elasticity. The value of the horizontal reaction for unit load at varying points on the rib was then calculated on the assumption that the abutments were rigid.

Knowing these, the horizontal reaction for varying conditions of loading may be determined; influence lines could have been drawn, but it was considered sufficient to investigate certain particular positions of the load which produced the worst conditions. The horizontal reaction once determined, bending moments, shear forces and thrusts were calculated. Worst values of each were found and the stability of the rib investigated.

The design of transom, roadbearers and decking were then considered.

It is hoped this description together with the accompanying sketches will make the design clear and be of some interest. The bridge was designed for a live load of five tons.

THE VALUE OF WORKS SERVICE AS ENGINEER TRAINING.

By LIEUT,-COLONEL W. D. M. CHRISTIE, R.E.

(A Pre-War Contribution.)

IN an article "Engineer Training" which appeared in the June, 1938, number of *The R.E. Journal* its author suggested that Works service cannot be classified as training for war. In fact he went further and added that work of this nature is the antithesis of military Engineering. He stigmatized it as "sterile."

The general conclusions of the article were that all war-time engineer problems can be met by peace-time training on the Staff, in purely military employ, in engineer units (e.g. field companies, searchlight units) and by specialist training. The argument is based on what are conceived to be the main R.E. duties in war,
and the list includes such items as water supply, accommodation, roads, communications generally and elementary electrical and mechanical work. The point is made that improvisation is most important, coupled with practical experience and a general knowledge of engineering principles.

In criticizing Works services in peace it is stated that improvisation never arises, designs are standardized and opportunities for independent thought are few.

It is proposed in this paper to examine the main assertion that Works service is, in effect, of no value for war. In particular it is intended to show that practical experience in numerous engineering activities can be obtained as a result of a tour in a Works appointment and that a flexible mind can still be maintained. A few words will be said on the blessed term "improvisation" and certain other advantages of Works service will be mentioned.

It is first necessary to get a fairly concrete (as distinct from an abstract) idea of what probably are the Corps duties in war. These were admirably summed up in an article published in the March, 1938, R.E. Journal, from which the following extract is taken :—

"Let us at once disabuse ourselves of the idea that the work of the Military Engineer on service will be a continual sequence of hasty demolitions and pontoon bridging. A glance through the pages of *The R.E. Journal* since the Great War, and a little thought, will show us what his work will really be. It may be the erection of hangars in Iraq, or road and permanent bridge construction on the North West Frontier of India; it may be the provision of temporary accommodation for reinforcements in the Far East, or the installation of cold storage plant for extra supplies required in the Mediterranean; it may be the repairing and running of a power station or water-supply system after an earthquake or bombardment, or organization of quarries in Palestine. Even in a major war, the majority of the Corps will be employed on works of this description.

"The qualifications required for this class of work are, in the officer sound practical engineering knowledge; the knack of improvisation (which really means the possession of such complete knowledge as to be able to know what will 'do instead'); a temperament undisturbed by difficulties; and the capacity for getting work out of his subordinates."

If the above is accepted as a fair picture of the main R.E. duties in war, one cannot cavil at the assertion that improvisation must follow from a sound knowledge in the first place, and is not independent of it. Improvisation is not getting a job through by some form of "botched work."

How is the junior officer going to get this knowledge? The answer is only by practical experience. Let us, therefore, consider what a Works job, however lowly, should teach him :—

First, there is a knowledge of trades and materials. Even on minor maintenance work he can learn a great deal about carpentry, brick-laying, plumbers' work, painting, etc. He will have men of such trades in a field unit, and when he wants them to improvise a job, he must know what they can or cannot do. Similarly he will get a good working knowledge of the materials they work with, for instance, whether white deal would do for a job or whether something better is required. He should learn how long quite simple jobs should take and the result of the failure of the plumber to bring his tools with him. This is a subject on which most of us are regrettably ignorant.

It may be argued that this can be learnt in a field unit, but the wider scope of Works jobs and the longer time spent on them will undoubtedly produce better training.

There is next a specific knowledge of the engineering activities quoted by the author. Take roads: how often, except on the North West Frontier of India, does a field unit get experience in road work? A Works officer will always have some roads in his charge and even if it is only maintenance he will learn something about road specifications, materials, capabilities of rollers and so on.

Accommodation on a large scale will be needed on the L. of C. in war, and this will in Europe and the near East consist of steel-framed structures. In nearly every Works district experience can be gained in handling and erecting this type of building when Store sheds, large garages, etc., are erected.

Water supply on an extensive scale is required in war, involving high-level reservoirs and a piped system, and this very ordinary type of work can be learnt in a Works job.

Reinforced concrete will undoubtedly play a large part in war, both in forward defences and further back, and experience in work of this nature will nearly always be obtained in any G.E's district, even if it is only casting a humble roof slab.

Even such a mundane type of work as drainage and sewerage produces valuable experience. In the writer's own district a scheme is in progress at the moment which produces most valuable engineer training. Trenches have to be dug to depths up to 18 feet, the bottom six feet being completely water logged. Problems of pumping, revetting, lowering of weights up to 2 tons with improvised tackle to the bottom, levelling and pipe laying are all being met with. In addition there is the control of 500 to 600 labourers, provision of tools for them, consideration of when task work can be employed and when it cannot, and a host of problems all needing thought and a flexible mind.

An officer who has put such a job through successfully has got some valuable experience behind him, and both his organizing and technical ability in the field will have received a searching test.

It is unfortunately necessary to add that this work is being done by a young civilian engineer, as no R.E. officer is available for such Works duties.

It is hardly necessary to emphasize that new construction jobs, particularly abroad, where skilled contractors are rare, provide most valuable experience, but the author was careful to avoid condemning all Works service out of hand. On the other hand, were Works services appointments drastically reduced it might not be found possible to produce R.E. officers for such jobs when they arise, particularly as it is not always practicable to switch officers from job to job. At the time of writing, the effect of shortage was already beginning to make itself felt. In Quetta, for instance, where extremely valuable engineering experience could be obtained as a result of the major reconstruction going on, there were eleven "Engineers-in-Charge " of different portions of the work; of these only two were R.E. officers.

The following example illustrates the type of experience being lost to the Corps. One of the jobs was the rebuilding of a small outstation some 60 miles away, close to the Afghan border. This involved brick and reinforced buildings, a water supply scheme, drainage and a considerable amount of earth work. The Engineer-in-Charge was (except for visits) entirely on his own, and was required to make numerous decisions. He had a number of general problems to deal with in regard to labour administration and relations with local military and civil authorities. In passing, it might be mentioned that a severe water famine nearly brought building operations to a standstill, and some rapid improvisation had to be carried out.

Administration and relationship with other arms opens up another line of thought. The running of a Works Office will not only teach the administration of engineer work (e.g. supply of materials, tools and plant, scales of accommodation, estimating, etc.) but also provides an excellent insight into the administration of the Army as a whole. It is frequently stated, that a Sapper officer should be able to take on any "Q" job without further Staff training. Even if this is an exaggeration there is no doubt there is considerable truth in the assertion, and in any event a good working knowledge of the composition and administration working of other arms is obtained. More important, however, is the personal factor. In a Works appointment junior R.E. officers will meet and have to discuss very frankly many problems with senior officers of the other arms. A good Works Officer should be able to make valuable contacts with officers of all branches of the Service, which on actual service should stand him in good stead. In war a section frequently has to work with a battalion and a pre-knowledge of the foibles of battalion commanders as a class is bound to be of the greatest assistance to a subaltern who has to work with them in times of nervous strain.

The Corps is unfortunately something of a mystery to other arms, but a smartly turned-out young Works officer who shows the flag by going round the station, by mixing with officers of all categories and by showing an obvious desire to help them over petty inconveniences can do a great deal to break the barriers down.

It is considered, therefore, in the light of the above that the author's strictures are unfounded. There are, undoubtedly, jobs which are sterile, but something always can be learned from them. (Incidentally there are even some sterile regimental appointments.)

There is no doubt that some specialist Engineer training in addition would be of the greatest value, but this is a big problem and needs consideration of its own. Meanwhile let us hasten slowly, and be chary of throwing over a system which has given in the past, and is in the present giving to a large number of officers excellent training in the very large number of engineering activities that will undoubtedly be required in modern warfare.

AN ISLAND SURVEY.

By LIEUT.-COLONEL D. W. PRICE, R.E.

SURVEY in war is principally a matter of making the most of the opportunities that the vagaries of the campaign afford. Quite apart from the effect of enemy activity on the security of one's tenure of the ground, the General Staff expect quick results and have a right to get them. In peacetime, surveyors are accustomed to the need for cutting their coat according to their cloth, but the trouble in war is that it is also apt to shrink in the making.

The following is an account of a peacetime survey in which the type of requirement, coupled with the shortage of hands and time, led to the acceptance of improvisations that would hardly have been tolerated in more deliberate surveys. As circumstances of this sort are apt to occur in war it is suggested that it is not inopportune to recall them now.

LINING UP.

In the summer of 1935 the Royal Air Force sent a flight of aircraft from Iraq to the Persian Gulf to photograph the island of Bahrain. Although it was only intended at the time to make a mosaic, the photographs were taken in strips with the usual overlaps between individual photographs and between adjacent strips. The results were so good that a demand was raised for someone to go and carry out a ground survey in order to provide the control for a map.

Spare surveyors are however not easily found, and it was eighteen months before one became available for the work. There was at that time a small unit in Iraq called the Desert Survey Party, operating under the Royal Air Force.



1.---A street in Manama, the capital.



 The foreshore, showing Qalat al 'Ajai, the Portuguese Fort, of which one turret was used as a trig-station.



3.---A scene in a clearing in the palm trees,



4.—Pearl fishers at Manama.

An island survey, 1, 2, 3, 4

In December, 1936, the subaltern in command of this unit, together with a corporal from the Drawing Office at Air Headquarters, Hinaidi, was sent down to Bahrain to do what he could in the shortest possible time. Though no limit was fixed it was intended to be a sort of holiday task for Christmas.

No one quite knew what sort of map was required, and it was left entirely to the surveyors to decide what would best suit local conditions or, to be more accurate, what they were capable of producing with the equipment and time available. With this uncertainty, the equipment taken was very nearly all that Iraq could provide, not that that amounted to a great deal. But getting it on board the ship at Basra was reminiscent of the embarkation in "The Hunting of the Shark." It included two theodolites (one of them a Tavistock), a plane table, two chronometers, an Invar tape lent by the Iraqi Government, several other tapes, a number of prismatic compasses, aneroid barometers and thermometers, a sheaf of banderoles, the usual black box full of stationery, nautical almanacs, log. tables, etc., and lastly a shovel, without which no survey can ever be successfully carried out.

H.M.S. Shoreham, one of the Persian Gulf sloops, happened to be at Basra at the time and a call was paid on board. When it was explained that, so far, all attempts had failed to discover whether any previous work had been done in Bahrain, the navigator presented the survey detachment with two recently produced charts of the Gulf. One of these contained a note to say that in 1932 a party from H.M.S. Ormonde, using an astrolabe, had determined to two decimal places of a second of arc the exact position of a nail in the roof of the Political Agency at Manama, the capital of the island. Quite apart from the fact that it would have been beyond the capacity of our surveyors to split seconds on their own, this was a most valuable piece of information. It at least ensured that the map when produced would show the island exactly where the Admiralty were of the opinion that it was. In exchange for the charts it was promised that the position of other and rather more prominent objects than the aforesaid nail should be determined and given to the Navy.

Ships cannot go alongside a pier at Bahrain. Even the smaller class of B.I. boat has to anchor about two miles off the coast. The passage to the shore is made in a local craft, which proceeds to a little stone fish jetty at Manama or, if carrying more or less distinguished travellers, to the Political Agent's slipway. Whether it was due to warning signals from Baghdad or to the coincident arrival of a new assistant P.A., our detachment was honoured not only by being brought to the slipway but by being met by the great man himself and invited to breakfast.

Apart from this auspicious beginning the arrival was ill timed. The new moon had just brought Ramadhan to a close and it was the day of the feast which followed it. It was the Arab equivalent of New Year's Day in Scotland. Having brought the surveyors ashore in his launch, in the absence of porters or any other form of transport, the P.A. was now obliged to lend his car to enable them to complete their journey to the R.A.F. Rest House, which was to be their headquarters.

That was however, all that could happen on the day of the Id—a day made dismal with the wailing of pipes and the sobbing discords of the Arab merry-making.

It was hoped that the next day should mark the start of progress, but that too turned out to be a *dies non*, evidently a customary provision for recovery. Even the arrival of such an unusual thing as a survey detachment could not stir Abdul Aziz, the rest house keeper, until well on in the afternoon. A graduate of Beirut University and reputed to be a relative of the Shaikh, his sole assets were a courteous and dignified manner and the very best of connections.

It was arranged that Abdul Aziz should obtain a car and driver for the exclusive use of the surveyors. He would also engage a gang of coolies to clean up the rest house, which was in a deplorable state, and dispose of the litter, chiefly bottles, that covered the acre or so of sand enclosed within its mud walls. Only after many days of careful routine inspections was the bottle crop finally garnered. Incidentally it is no easy matter to quench one's thirst in Bahrain. The drinking water comes from Bombay and is sold in drums, while the sale of alcohol in any form is forbidden except with the sign and seal of the Political Agent. Judging from the evidence scattered about the rest house, there was little risk of the P.A. exercising his powers of veto.

The car duly arrived on the morrow, driven by Abdur Rahman, a cousin of Abdul Aziz. He was a good honest soul that soon became an enthusiastic surveyor's "mate," besides acting as chauffeur, guide and interpreter where necessary. It was very fortunate that he had not been brought up to regard cars as primarily designed for road travel. What was good enough for a camel, was always good enough for Abdur Rahman and his car. He was also one of the few real experts on the topography of his island. Through him, quite a number of names were collected which were unknown even to his own Government.

Pending the arrival of this transport calls were made on the island's notabilities, including the Adviser to the Shaikh and the local manager of Cables and Wireless.

The Adviser was a man of multifarious interests, a sort of good uncle to the whole island. As the representative of Government he welcomed the idea of an up-to-date map being made and gave permission for the party to roam at will throughout the Shaikh's domains. From the Adviser's archives was obtained a copy of an ancient map of Bahrain published by the Survey of India during the latter half of the last century. Like the Admiralty charts, the existence of this map came as a complete surprise. Although only the northern portion was surveyed, it was of the greatest help. Of less assistance was the offer of a number of unrelated plans of small holdings at various scales produced by the local Government. After examination they were returned.

Arrangements were made with the local Manager of Cables and Wireless for time signals to be received at what must have been to him most inconvenient hours. One which was particularly favourable for star observations used to occur at three o'clock in the morning, local time. In return for these concessions the Surveyors undertook to check the perpendicularity of his wireless masts and to determine the location of a new direction-finding station then being built. Direction-finding happened to be a delicate subject in Cables and Wireless circles, as only that summer an Imperial Airways liner had lost itself in the neighbourhood of Bahrain and been forced to alight in the desert on the mainland,

Calls were also made on board the sloops anchored in Khor al Qali'a, a natural harbour sheltered from the north by Muharraq, an island lying just off the north east corner of Bahrain. Invitations to live on board had reluctantly to be refused, but the two Surveyors were respectively made honorary members of the officers club and ratings canteen at Jufair.

A FALSE START.

The first journey made in Abdur Rahman's car was to visit the British American Petroleum Company, locally known as "BAPCO". It was also the first sight of the interior of the island.

Bahrain is a little larger than the Isle of Man. It is roughly wedge shaped, 30 miles long from north to south, 11 miles wide near the northern end and tapers to a long spit of sand at its southern extremity. The northern seaboard is flat and covered with palms. The rest is sand and coral and rock, rough going and for the most part hilly. A depression 12 miles long and 4 miles wide, enclosed by low cliffs, occupies the centre of the island. In the middle of this shallow crater stands a rocky massif whose summit peeps out over the top of the surrounding cliffs. This is Jabal ad Dukhan, the "Hill of Smoke." The oil wells and the camp cluster round its lower slopes.



A good road links Manama with the BAPCO settlement, which was known to Arab and European alike as "Jabal." In 1936 the only other road ran northeast from Jabal past the refineries to the small island of Sitra, which nestles close to the eastern flank of Bahrain and carries the oil storage tanks.

The intention was to find out how much survey BAPCO had carried out, whether this would suffice to provide the control for the air photographs or alternatively whether it could be used as a basis from which to extend the work over areas not yet covered.

No one could have been more co-operative than the BAPCO surveyor. Though it occupied two whole days, he obviously enjoyed showing his visitors round the work that had already been done. His enthusiasm was infectious. Already it seemed that little more was required than to pin-point the BAPCO system on to the photographs. But repeated failures in attempts to extend the oil company's work began to give rise to certain misgivings. In the circumstances it had seemed almost improper to ask what instrument had been used for the survey, but it had to be done.

The request was readily acceded, and a rather corroded piece of mechanism, referred to as a "transit," was produced. In the humid Gulf atmosphere almost everything metal in Bahrain becomes corroded sconer or later, so that in itself signified nothing. But what was remarkable was that the transit only read to the nearest minute. The BAPCO surveyor was fully aware of this particular shortcoming but had hoped to boost up his accuracy by taking a multiplicity of readings.

It would be ignorant to criticise. Oil companies carry out surveys for purposes of their own. Though they are vitally concerned with heights and depths, they are relatively careless about horizontal measurements, and it was a point that might have been appreciated before. It was certainly misleading to have been given all the co-ordinates of points to 3 places of decimals of a foot. But computing machines have a habit of working that way.

This was all most disappointing. Christmas was coming and it looked like a new start altogether.

A NEW START.

It is difficult to say at what stage it was decided to work on the basis of producing a map at 1 inch to 1 mile. At one time it was even suggested that two or three astronomically fixed points might be sufficient to produce the sort of map that was required. Nothing much larger than a scale of 1/250,000 would have been possible by these methods, and it was clear that the detail of the oilfield would be lost if a smaller scale than about 1/50,000 were used. It therefore followed that a triangulation would be required. The Government of India, in whose sphere of influence Bahrain lies, uses inches and miles rather than a metric scale, so in deference to them it was agreed that miles and inches it had better be. The scale selected was 1 inch to 1 mile.

The work done on the BAPCO system had not been altogether wasted and little further reconnaissance was necessary. It did not therefore take more than another six days to cover the island with a plane-table triangulation, as a preliminary to carrying out observations.

Except in the north, little difficulty was encountered at this stage. The lip of the crater provided an unusual aid to triangulation, as a glance at the sketch map will show. The trouble in the north was due to the combination of flat country with an extensive and almost continuous growth of date palms. Short of building towers of the type illustrated in the *Textbook of Topographical Survey* and recommended for this kind of problem, there seemed to be no solution. While pondering, like the man in the parable, on the practicability of building a tower, our Surveyors observed that one already existed, or to be more accurate, two, close together.

There was a pair of disused minarets which stood side by side in a little

clearing and whose domed white tops could be seen above the trees from almost anywhere. About 20 feet down from the top of each minaret was a little wooden balcony, access to which was by means of a spiral staircase up the inside. Permission was obtained and the ascent made to the more robust of the two balconies. It was about a foot wide and supported cantilever fashion on a narrow corbel which ran round the minaret. It was judged that with patience it would be possible to take observations with a theodolite from the balcony. It was also noted that of the few objects that could be seen above the trees from this vantage point there were the Agency flagstaff, the Naval flagstaff at Jufair and one of the turrets of Qalat al 'Ajaj, an old Portuguese fort. These were admirably situated as far as triangulation was concerned.

Further reconnaissance showed that the Political Agency and the Naval Canteen were conveniently adjacent to their respective flagstaffs, and that from the flat roofs of these buildings it was possible to see the top of the minaret, but not, unfortunately, the balcony.

This particular solution of the problem of seeing over the palm trees therefore produced the rather alarming situation in which the stations occupied at each corner of one of the triangles were all necessarily satellites. Fortunately it was the penultimate triangle of the system and the disadvantages were accepted.

In the centre of the island most of the stations selected were on the tops of old tombs, reputed to be Phœnician or, as some said, of the forerunners of the race that later migrated and established itself on the Mediterranean shores. These mounds of stone or gravel, shaped like upturned pudding bowls, are numerous enough in certain places to give the ground the appearance of a rash when viewed from the air. A few of them are as much as 50 feet high, and these gave excellent command, even over the date palms.

In the extreme south, the island tapered off into a low-lying desolation of sand, uninhabited and almost featureless. It would have been a laborious business extending the triangulation over it, and it did not seem worth while making the attempt. During observation later, a ray was taken on to an object on the final spit of sand in order to correct any tendency of the photographs to swing out of their true bearing.

A site for a base was also selected in a flat sandy stretch of country between the edge of the palms and the rough stony slopes that surround the central crater.

While the reconnaissance was in progress, a workshop for the manufacture of beacons was started in the rest house and placed under the direction of Abdul Aziz. Except for some deal looted from a number of old bomb crates, teak was the only kind of wood procurable, so that the beacons were both heavy and handsome. Each one was surmounted by a flag of red and white calico, which was casily obtainable in Manama. It also had the advantage of being the Shaikh's colours. Although this did not deter all his subjects, it undoubtedly helped to reduce the number of beacons stolen. Four days were spent in erecting beacons. After the initial reverse and the more recent troubles with the palm trees, the sight of beacons rampant on every high hill did a great deal to raise the *morale* of the survey party. Here was the first visible evidence of progress.

OVER THE FENCES.

It was now possible to start observing. In the circumstances it was decided that three readings on each face would give sufficient accuracy. Mirage and shimmer, normal features of the Arabian atmosphere, restricted the time at which observations could be made to the morning and evening for horizontal angles and to the middle of the day for vertical. Sometimes points observed during the mirage conditions of the early morning would disappear altogether later in the day. In these conditions progress was maintained at an average rate of rather over two stations per day, and the observations were completed in 12 working days. Spare beacons had always to be taken to replace those that were stolen. On two occasions reserves were insufficient to make good the depredations of the inhabitants and the plane side of a shaving mirror was successfully used to give a light signal instead.

Observations from the minaret gave rise to more trouble than had been expected. As the balcony was so very narrow, it was impossible to observe in any direction that was not more or less tangential to the minaret. This led to the necessity of setting up no less than three separate satellite stations, each linked to the other by including two common rays. This kind of ingenuity could hardly be recommended as sound survey practice, but it served in the circumstances. The other result of the balcony's dimensional shortcomings was that no round of angles could be completed without the observer twice making a circuit of the minaret. Quite apart from the difficulty of this operation for the observer, it was also very tiresome for the booker, as he was sharing the same perilous perch and had periodically to withdraw inside the minaret, rather like a figure in a Swiss barometer, in order to allow the observer to pass.

Almost the last station to be occupied was the roof of the Political Agency. It had always been imagined that the nail mentioned in the Admiralty chart would have had some place of special honour and be suitably safeguarded from carcless extraction. Exhaustive examination of the roof however completely failed to locate it, and a search was then made for a brass plate in the agency garden, which was also described in the chart. The plate was quite easily found, sunk into a millstone, buried where four paths met: but, however carefully the directions inscribed thereon were followed, it was quite impossible to get anywhere except to a point in the middle of the tennis court. The survey seemed to be in grave jeopardy. As a final resort local tradition was tapped and the P.A.'s wife was asked where the Naval Officers had set up their astrolabe in 1932. It was then that the shocking truth was disclosed that this most precisely located nail was now under the summerhouse that she had recently had built on the roof. Sic transul the second decimal place of a second of arc !

Fortunately it was still possible to deduce within a few inches where this precious nail had once been, and it would have been quite impossible for the survey party, equipped as it was, to obtain results any nearer the truth. A check was in fact made by means of intersections of Qassar Diwan beacon, which was another point located by the hydrographers, and the results approximated very closely indeed to their figures.

As a sequel to this incident all reference to the nail has been discreetly expunged from later editions of the chart.

During the period occupied by making the observations the alignment of the base was prepared. Several dry stream beds intersected the ground selected, but all these were shallow and could be easily bridged by building small causeways across them. It was found possible to make up a stretch about 1,000 yards long smooth enough for direct measurement on the surface. A small team of Arabs was trained to assist in the work. Three measurements were made. The first was a trial run and was ignored, but the next two agreed to within 0.3 inch, and the mean of these two was taken as being sufficiently accurate for the scale of map which it was proposed to make. Base measurements occupied two days.

THE HOME STRAIGHT.

Little remained now except to observe an azimuth for the triangulation system and another for the directing-finding station. About 50 observations were made for the triangulation system, over a series of nights whenever conditions were favourable, which was relatively infrequent in January. Even on good nights the continuous condensation on the lenses made work difficult. The D.F. station still lacked a portion of its roof. This was very fortunate as things turned out, for it was thus possible to set up the theodolite over the centre of the station and observe an azimuth directly. It seemed strange that a D.F. station should ever have been built without precise knowledge either of its location or the direction in which it was oriented.

Apart from the heights of trig. stations, such heights as were measured were obtained by aneroid barometers. These were supplemented by the very accurate data supplied by BAPCO, who, as already mentioned, took vertical measurements most seriously. The disadvantage of using barometers is that they require an observer to remain at the base. This condition rather curtailed the activities of so small a party, and consequently the amount of height data obtained for certain parts of the island was scanty.

The survey had taken thirty working days. Of these, two had been spent in making contact with local authorities, ten on reconnaissance, four setting up beacons, twelve on observations and two on base measurement. A further six days were spent in waiting for the boat, and during this period most of the computation was done. The pin-pointing of photographs was also carefully checked, beacons were taken down and brought back to Manama, some of the work which had been carried out in unfavourable conditions was re-observed and a few more aneroid heights were determined.

At the end of January the party embarked for the return to Basra. The ship took three days to complete the passage, by way of Bushire and Kuwait, which gave sufficient time for the remaining computations to be completed.

One incident of the voyage serves to illustrate a peculiarity of Gulf politics. A certain citizen of Bandar Abbas decided to emigrate with his family to Bahrain. As it is considered in Iran to be an Iranian island, no passports were provided. When he reached Bahrain, however, he found a different impression prevailing and was naturally refused permission to land. The next port of call in Iran was Bushire, but here it was the sea rather than the immigration authorities that intervened, and he had to be taken on to Basra. There he and his family were last seen, still prisoners on board. Such are the inconvenient results of the observance of political *amour-propre* in the Orient.

The map was compiled on the Iraq Lambert grid under the direction of the corporal of the party, in the Drawing Office at Air Headquarters, Hinaidi. The compilation was then sent home to be drawn and printed by the Ordnance Survey.

It is scarcely to be hoped that BAPCO have left the face of Bahrain unchanged during the last five years, and no doubt someone will in due course have to go and survey it all over again. It there is any moral in this story, he would be wise to make a completely fresh start.

GERMAN SUGGESTIONS FOR THE MILITARY TRAINING OF CON-STRUCTION UNITS.

(Translation of an article by Lieut.-General Klingbeil in the Militar Wochenblatt of the 5th June, 1942.)

It would appear from this article that the Germans have experienced considerable trouble from attacks on their L. of C. in Russia.

As their construction battalions are composed mainly of old men and lads under military age, the counsel given is of the perfection nature and may be designed as propaganda to scare off enemy raiders. The nature and severity of the fighting on the Eastern Front has often made it necessary to employ Construction troops (*Heeresbautruppen*), as infantry, although their proper duty is the execution of technical work, such as the removal of obstacles, road and bridge building, field fortification and hutting. Apart from the not infrequent cases in which the situation required that they should be used in defensive battles in the front line as infantry pure and simple, they have been continually engaged behind the front in dealing with small scattered parties of the enemy left behind during retreat, parachute troops, commandos and guerillas.

The battle training of the Construction units must be adapted to the tasks they may be called on to perform. Their instruction will therefore be directed particularly to :

(a) Protection on the march ;

(b) Protection of the site of work and billets ;

(c) Defence;

(d) Attack with limited objectives.

Tactical instruction will go no further than the duties of the group and platoon. The time available for military training is too short to allow of more than very limited instruction in the basic principles of company battle training; but the more surely these are grasped, the better will the units be fitted for employment in the theatre of war.

The fighting duties of Construction troops bear close relation to their technical use. This must not be overlooked in their training and in the duties allotted to them. For training purposes the exercises should be set in carefully chosen localities in brief and military form. All technical tasks in which enemy interference is possible should be made more realistic by sham attacks. For instance by tanks, cavalry, motor-cyclist riflemen, push cyclists, infantry patrols, gas and aeroplanes.

The following are examples, shortly stated, of some of the training exercises. They show how many-sided is the infantry work demanded of the Construction troops in combination with their technical duties.

(a) MARCHES AND PROTECTION ON THE MARCH.

Construction troops are often called on to perform laborious tasks at the end of a long march. In order to accustom them to the strain of marching it should be arranged from the very outset of their training that the length and difficulties of march are progressively increased, march discipline not being forgotten. On the completion of a technical job, Construction troops have, often alone and in darkness, to try to catch up the troops in front. Protection must be put out in such marches, for at any moment—particularly in close country—units may run into parties of the enemy. Anti-aircraft protection by means of light machine guns or rifles must be provided. An air look-out may be necessary. Other points to be attended to are : air alarm ; action during air attack ; precautions during halts and rests ; rapidly made obstacles and blocks ; night marching ; use of the compass ; protection of transport by rail and motor against ground and air attack.

(b) PROTECTION OF SITE OF WORK AND OF BILLETS.

In the protection of the site of work the close relation between military duty and technical work is very strongly marked. All technical work, especially bridge and road construction, requires protection against ground and air attack. The best protection is scouting—in winter on ski.

For the protection in the direction of the enemy—often also on the flanks and in rear—groups must be detailed and pushed out sufficiently far from the site of work to hold off small hostile parties effectively. It should not be possible for hostile patrols to take the site of work under fire. The groups must receive

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clear instructions for their action in the case of an enemy attack. Co-operation and communication between the groups as well as to communication to the rear must be arranged.

The working parties must always have their weapons handy. Their action in case of attack must be clearly laid down and the service instructions as regards air and gas attacks fully explained to them.

War experience has shown that it is most important to arrange protection for billets, even when they are situated a long way behind the front. Surprise by raiders must be expected. Thorough training in outpost duty is indispensable.

(c) DEFENCE.

If the enemy attacks the protective line, defensive measures become of increased importance.

The groups must be practised in the defence of particular sectors, and, when necessary, in putting the plan into effect at the highest speed ; whilst defending their own front by fire they must be able to assist their neighbours by fianking fire. The light machine gun should usually be in the middle of the group, with the riflemen in nests of two or three around it. The control of the whole group by its leader must be ensured. Axiom ; fire effect comes before cover !

Other points are: choice of position in regard to light and background, camouflage, avoidance of conspicuous points and edges of wood, alternative positions, digging of rifle pits, dummy positions, use of doorways and windows of houses, but shooting to be done from the interior of the house not its openings, action against air attack and tanks, preparations against night attack.

A group must always receive a definite outline of instructions for its attitude.

In the case of a platoon, parties must be held in readiness for employment on the flanks and in rear.

(d) ATTACK WITH LIMITED OBJECTIVE.

Should the protective parties fall back in the face of superior force, or should the defensive line be broken through at any point, so that the execution of the technical work is endangered, the commander on the spot will by the regulations decide to make a counter-attack with limited objective with the troops at his disposal. It will be either against the wings, flanks or rear of the enemy, or against weak places in his front.

Besides this, there must be a quick change from working to fighting, the rapid formation of a battle organization, and the issue of clear and definite orders. An attack with limited objective can as a general rule be expected to achieve only a limited success, in proportion to its strength. It should in any case be sufficient to stop and pin down the enemy. The objective should not be far distant, and in the first place will be sought with only weak forces; it may, however, demand the engagement of all available forces. Against a determined enemy, hand-to-hand fighting may ensue, so the Construction troops should be masters of this (including grenade throwing). Whether the enemy should be pursued or a halt called at the right moment is a matter of very careful consideration. In dealing with guerilla parties in wooded country, the searching of woods may be desirable.

To ensure that full use of favourable opportunities is made, subordinate leaders must be allowed a certain amount of freedom for offensive action. The leaders must therefore be specially trained in coming to decisions and using their wits. Examples: (a) counter-attack against an enemy who has broken in (first drive the enemy to cover by fire and then attack); (b) damage to an enemy who has penetrated into an adjoining sector (by fire, feigned attack, blow against his rearward communications, night surprise against a flank).

Supporting nests of the enemy should be attacked by pincers, not frontally; pin the garrisons down by frontal fire and then attack by pincers, using covered

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approaches along valleys and depressions and through woods. The timing of such operations is important, for the flanking parties have the longer way to go. The hour for attack may be fixed by the watch, or light signals used.

During the hard winter-fighting on the Eastern Front the Construction troops were often used in defensive battles right up in the front zone. On such occasions, having only rifles and light machine guns, they were suitably reinforced by the heavy weapons of the infantry and signal parties. It is therefore necessary that the officers of the Construction troops should be thoroughly acquainted with the proper use of the heavy infantry weapons and the fighting methods of reinforced infantry battalions, and be in a position to give suitable orders.

CONCUSSION CHARGES.

By MAJOR J. H. GILLINGTON, R.E.

In an article of the above title in The R.E. Journal of September, 1947, Major Peart describes the demolition of a house and outbuildings to remove a "flying obstruction " near an aerodrome and states " this demolition is further proof that the formula $C = \frac{KAT^2}{IO}$ is very extravagant in explosive, at any rate for

buildings of this nature. A linear expression would seem more reasonable, if the resulting couple from unequal charges is considered as the destructive agent."

The S.M.E. adds to this a note that " it appears that a formula $C = \frac{KST^2}{5}$ where S is the total parimeter of the supervised of the second sec

S is the total perimeter of the room in feet, gives charges approximating more closely to those found adequate in practice."

My unit has recently demolished a farm house and outbuildings (also a "flying obstruction ") using the suggested formula, with the following results :--Sec. Recent 1

The details of the two main buildings were :---

(i) Farmhouse (Fig. 1). Two storey brick building 36 ft. 6 ins. × 30 ft. 6 ins.

Two 131 inch walls, two 9 inch walls. Four rooms and central passage on each floor with 41 inch partition walls. A cellar underneath one room. Attached to and treated as part of the house, a room 16 ft. 6 ins. × 16 ft. 9 ins. with 9 inch walls. There were also various lean-to outhouses attached to the house (including a two-seater " chummy " lavatory-almost a museum piece !) but these were not taken into consideration.

(ii) Barn (Fig. 2) 9 inch brickwork with twelve 131 inch pilasters supporting the long walls. Single storey about 36 ft. high, divided by a 9 inch wall into two unequal parts, the smaller being a cart shed below, with one side completely open up to 8 ft. high, and a hay loft (only a few joists left) above.

Both buildings were in good condition structurally but had been stripped of doors, floors, windows and everything else that could possibly be of any use. Only a few scrap bits of wood were left. The roof of the barn was in poor condition. The other buildings were mainly roofless and in bad repair.

The nearest inhabited building was a farm 250 yards away.

CALCULATIONS.

Farm house. Charges were calculated room by room for the five ground floor rooms, ignoring the central passage and also ignoring any additional support that might be given by the chimney stacks on each side of the house.

Taking K = 2 (for good brickwork) and roughly averaging the thickness of the outside walls in each room (e.g. where one 9 inch wall and one 131 inch





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wall of approximately equal length formed the outside of a room T = 1 the charges for each room were calculated on $C = KST^{3}/5$.

Charges were then unbalanced by taking from one room and giving to another, keeping within the total, and the final figure was 93 lbs. of explosive arranged as in figure I.

Barn. Treated as two rooms, $K = 2, T = \frac{3}{4}$ (ignoring the $13\frac{1}{2}$ inch pilasters) total charge 51 lbs. arranged as in figure 2.

Here had to be considered the dictum in M.E. Vol. IV para. 38, that "it is important that all doors, windows, chimneys and other apertures through which air can escape should be closed and blocked with sandbags or other suitable material. Where this is not possible, the charge should be doubled" (not my italics). Lack of materials and time made it impossible to block everything and, as described later, the blocking done was extremely skimpy, but it was decided, in spite of the emphasis of M.E. Vol. IV, not to double and to see what happened.

In spite of great temptation on considering the apparent smallness of the charges and the gathering which had assembled "to see the old farm go up" no additions to the calculated charges were made "for luck."

LAYING OF CHARGES.

Charges were of ammonal, measured out beforehand into tins rescued from the salvage dump. They were laid untamped and were on the ground in every case except the 20 lb. charge in the house, which was at ground level on a joist over the cellar, and the two 8 lb. charges in the barn, which were balanced on joists of the old hay loft about 8 feet above the ground. Charges in the rooms were placed about 2 feet away from the centre of the room towards the external corner.

While the charges were being laid, such work as was possible in boarding-up openings was carried out. In the house, all the ground floor openings were very roughly boarded with scrap timber, no attempt being made to make them airtight. The only effective block was an old mattress hung over one window—all the other blocks had a distinctly "cage" appearance. The chimneys and upstairs windows in the farm house and the two main openings in the barn were not blocked at all.

The time taken to lay charges and to do this blocking was 70 minutes by a troop of 30 working numbers.

FIRING.

Each building was fired separately. The farmhouse was connected up with a Cordtex ring main running round the outside of the house, with a branch to each charge. Owing to shortage of Cordtex a ring main could not be laid in the barn, which was fired on a single lead with branches to the charges.

RESULTS.

The farm house was fired first. There was very little noise and an immense cloud of smoke which cleared very slowly, to the intense excitement of the troops, who had been appalled by the smallness of the charges and had been arguing (with financial implications) as to the number of chimneys that would be left standing. The demolition was completely successful, the house having moved outwards a few feet all round and dissolved into a heap of bricks. Very little debris flew, the furthest brick being found 34 yards away.

The barn, in which the charges seemed even more minute and the openings even greater, was then blown with equal success. Some of the roof tiles travelled 40 yards but no brick was further than 30 yards away.

A stone staircase leading to the hayloft was also destroyed.

The formula was then tried on another outbuilding, which had no roof at all. The walls bulged slightly but otherwise the building was untouched.





CONCLUSIONS.

(i) Calculation of charges.

The formula $\frac{\text{KST}^2}{5}$ gives completely satisfactory results on buildings of this

nature, and is very much less expensive than $\frac{\text{KAT}^*}{10}$ and less than Major Peart's

" rule of thumb."

Comparison of the total charges is (S taken room by room) KST* VATS . Rule of

			-	10	thumb	5
					·	·
Farmhouse	••		·	247 lbs.	125 lbs.	93 lbs.
Barn		• •	•••	284 lbs.	100 lbs.	51 lbs.
		-			** **	

It is pointed out however that for very small buildings (e.g. pillboxes) where A = 50 sq.ft. or less, $\frac{\text{KST}^3}{5}$ becomes greater than $\frac{\text{KAT}^4}{10}$ and it is suggested that

for such small buildings both formulæ be considered and the smaller charge used. From the complete lack of pressure wave or rush of air 70 yards from the

explosion, it seems that nearly all the force of the explosive was used on useful work, and it does not appear likely that the charges could have been safely reduced.

(ii) Boarding up of openings.

It appears that all that is necessary is for openings to be sufficiently blocked to offer moderate air opposition, as distinct from anything near air tightness. A roof of sorts, however flimsy, is essential.

FIELD DEFENCES IN THE WAR OF 1914-18.

(Extract from Corps History.)

IN a war that lasted over four years, of which the greater part was more or less static trench warfare, it was natural that considerable development and change should have come about in the nature and disposition of the defensive works, in the respective shares of the engineers and infantry in their construction, and in the numbers and organization of the engineer troops in the line. The change in the nature of the works affected not merely the design of the trenches, etc., but especially their tactical organization and lay-out, and the manner and strength with which they were occupied.

The regulations and the training before the war only envisaged the use of field defences for purely temporary purposes, and specially emphasized the necessity for the resumption of an energetic advance at the earliest moment.* The conception that energetic advance might prove impossible and that the operations might degenerate into the conditions of siege warfare had not apparently entered the minds of those responsible for army training. The manual, Military Engineering, Part II, Attack and Defence, published in 1910, defined a "stormproof " work as one of which " the design is such that, given a complete and efficient garrison, attacking infantry can be destroyed as fast as they can approach, no matter how great their dash and determination."† It went on to say that "a work can only be rendered storm-proof by the construction of a deep ditch, causing the assailants to crowd together at points where they can be shot down at short range either from galleries in the counter-scarp or from

* Manual of Field Engineering, 1911, Sec. I, para. 5. † Military Engineering, Part II, Attack and Defence of Fortresses, 1910, footnote to Sec. 2.

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caponiers projecting from the escarp." In short by the methods of the 18th century ! This too after the South African War, ten years earlier, in which Boer defensive positions consisting of simple trenches and barbed wire had proved themselves over and over again to be storm-proof ! The general attitude taken up in regard to instruction in siege works was that operations in a European war would be so mobile that the necessity for siege operations would be most unlikely to arise. One practice exercise in the attack of permanent defensive works was held in 1907, with a view to the possible contingency of a British Expeditionary Force, which had landed on an enemy's coast, finding itself called on to attack the permanent defences of the land front of a coast fortress. Apart from this little attention was paid to this subject. The experiences that could have been obtained from the siege and defence of Port Arthur in 1904 were ignored, nor was any attention paid to the German siege manœuvres of 1908. of which a full account was published in English. The annual training of R.E. field companies in mine warfare was cut down and the mining equipment, previously held on charge for training purposes, nearly all taken away. The infantry also got very scanty training in field entrenching. They were indeed discouraged from practising it at manœuvres by the rule that units who dug trenches must return afterwards and fill them in. Imbued with the spirit of the offensive, as inculcated by F.S.R., few divisional commanders either asked or took the advice of their C.R.E.s., or had any conception of the value of the assistance that the field companies could give, or of how to employ them. It is not surprising that the Expeditionary Force arrived in France very ill-prepared for the conditions which faced them after the few months of the opening phase of the war. These conditions, after the flanking movement to the north had reached the sea, soon became those of siege warfare. It was fortunate that the officers immediately responsible for the training of R.E. field units before the war, with the customary independence of thought of the R.E. officer, did not share the official view that the coming war would be of a type giving no scope for field or slege engineering. Both at home and in India experiments were carried out in the making up of extempore hand grenades, with the appliance known as the "Bangalore torpedo" for demolition of barbed wire, and with various other field and siege expedients, and field unit commanders did their best within the limits of the restrictions imposed from above to prepare their units for the work they saw coming.

In consequence of the omission of the higher commanders and staffs to study or practise the methods of siege warfare, all the lessons which might have been drawn from past campaigns were lost. The elementary tactical principles which should govern the lay-out and occupation of a trench system were unknown and even the nomenclature had been forgotten. As the Official History puts it1 " a fresh vocabulary was created to meet the new conditions." All trenches other than fire trenches were called " communication trenches " regardless of whether the communication was lateral or from the rear. The old word "approaches " used in the Peninsula and the Crimea, which gives a shorter and more soldierlike description of their purpose-namely to approach the enemy, not to retire from his proximity-had been forgotten. All forms of overhead cover, whether the flimsiest protection that would barely keep out splinters, or the deepest bomb-proof, were alike called "dug-outs." Mining became "tunnelling"; "grenades" became "bombs." Much worse than this however was the utter inadequacy of the supplies of entrenching materials, tools and trench weapons. In the first battles round Ypres barbed wire was almost unobtainable², entrench-ing tools scarce³, sandbags very inadequate⁴. The service hand grenade, of which the available supplies were very small, and which cost over £1 apiece, was quite unsuitable for trench warfare, since it had a long linen tail, and the stick grenade

¹ Official History, 1915, Vol. I, p. 152. ³ Official History, 1914, Vol. II, p. 273.

Official History, 1914, Vol. II, p. 154.
 Official History, 1914, Vol. II, p. 206.

had a percussion fuze which made it very unsafe to throw from a trench. No others were available from home before September, 1915, and in 1914 the field companies at the front were employed on the production of makeshift ones. No trench mortars were available and of these also rough and ready substitutes were made by the R.E. The German Army however, soon after trench warfare began, was fully equipped with hand grenades and trench mortars and also with light-ball pistols, of which none had been supplied for the B.E.F.

Towards the end of 1914, Captain B. C. Battye, R.E. (later Lieutenant-Colonel, p.s.o.), then serving with the Indian Corps, designed and produced for that Corps cast iron segmented hand grenades, filled at first with gun-cotton dry primers and later with ammonal. At the end of December, 1914, Captain H. H. Bateman, R.E. (later Lieutenant-Colonel, D.S.O., M.C.), of the 26th Field Company, acting under the orders of Brigadier-General S. R. Rice, then Chief Engineer of the I Corps, organized a bomb factory for the supply of the whole B.E.F. at 78, Rue de Lille, Béthune, where he produced, with French civilian labour as well as Sappers, bombs of the Battye design filled with ammonal and fitted with Nobel lighters. For nine months, often under shell fire, which luckily never scored a hit into the room where ammonal was being filled into the bombs, Captain Bateman and his band of workers continued to turn out bombs to an average daily output of 1,000 to 1,500. Including a special issue of 80,000 for the Battle of Loos, the total output of the factory came to about a quarter of a million. The output of the Béthune factory was the only reliable source of supply for the B.E.F. until supplies of cricket ball grenades with fuzee lighters, which however were useless in wet weather, came from England in September, 1915. The well-known Mills bomb began to be supplied soon after.

The trench works made about the time of the first battles round Ypres consisted of shallow trenches, in short lengths, often separated by gaps amounting to two, three, or even four, hundred yards*. As the fighting stabilized the trenches were deepened and connected up laterally. Trench positions for support and reserve troops were added later and approach trenches constructed. Thus the main elements of a defensive position were gradually built up. The fire trenches, which were at first very narrow, were made in short lengths separated by narrow traverses. As time went on they were widened to about 7 ft. at the top and 2 ft. at the bottom, with a depth of 6 ft. 6 in. or 7 ft., and traverses 12 to 15 ft. in width were made which really would localize the effect of shells. The communication trenches were either zigzag in trace or were also laid out in short lengths with traverses. In the winter months drainage of all trenches became a matter of great importance and great difficulty. Revetting soon ceased to be attempted except where it was necessary to build parapets above ground level and for this sandbags were the only material used. Overhead cover was long in coming about. At first it consisted of roughly undercut shelters (known as funk holes) in the front parapet, then these were enlarged and roofed with planks or corrugated iron with a little earth over. It was not till the summer of 1916 that real shellproof cover was generally provided. This delay was generally due to the insufficiency of engineer troops and organization for supplying material and also to the fact that most of the areas occupied in the winter of 1914/15 were in low lying ground where water was found very little below the surface.

The method of holding the defensive lines of the above description during the first two years of the war may be described as the "linear" system. It consisted in regarding the front line as the main line of defence on which the defensive battle was to be fought out at all costs. It was therefore occupied as thickly as possible, generally with about a man per yard of parapet. The support line, so to 100 yards in rear, was held at from a quarter to half the strength of the front line. For the first year of the war the shortage of troops seldom permitted of any being allotted to the reserve positions. In the winter of 1915/16 the "Official History, 1914, Vol. II, p. 175.

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normal practice of an infantry brigade holding a sector of the line was to allot two battalions to the front and support lines, one battalion to the reserve line about 1,000 or 1,200 yards in rear of the front line and to have one battalion in mobile reserve in a village a short distance behind the trench system. A division holding the line would have two brigades in the line abreast of each other and disposed as above, the third resting in villages two or three miles behind the trench system. The practice of holding the front line thickly led to a maximum of casualties from shell fire and did not prevent that line being penetrated whenever a serious attack was made on it. The great tactical weakness of the defensive systems till near the end of the war was that they grew up in a haphazard manner, with no forethought. The position of the front line, on which everything depended, was never deliberately selected on tactical grounds but was always that line on which the exhausted troops happened to be clinging when the last phase of active fighting came to an end. Any proposal to withdraw from a faulty front line position to another one with better tactical properties a few hundred yards in rear was anathema to the higher commands.

"Strong points" for all-round defence were first provided during the first battle of Ypres and also in the fighting in the winter of 1914/15. They were for the purpose of breaking up an attack which had penetrated the front line and providing centres of resistance pending an organized counter-attack. It was not till the summer of 1917 that the practice of holding the front line in strength began to be given up, and some divisions adopted the principle of holding the front line intermittently and relying for determined resistance on the reserve line. This tendency to make the main line of resistance further back continued to develop till early in 1918 the principle of the organization of the defence in depth was definitely adopted, and the method of applying it indicated, in instructions issued from G.H.Q. In these instructions it was definitely recognized that the foundation of the defensive organization must be the main battle position, selected by the commander as that on which he intended to fight out the battle and expend his last resources, and that in front of this position, and forming part of it, there should be an outpost position also organized in depth, and behind it some distance in rear, further positions of defence for use in the last resort. These last were sufficiently far in rear of the main battle position to make it necessary for the enemy to organize a second and distinct operation in order to attack them. Each of these three defensive systems took the form of an interdependent network of trenches, posts and defended localities, constructed with a view to securing the defence of all ground of chief tactical importance to the enemy. These posts were joined up whenever time admitted by lines of trenches, giving intercommunication everywhere and making it difficult for the enemy to detect the localities which were held in force. "Switch" lines of defence, connecting the forward works with those in rear, were provided to limit the lateral progress of an enemy who had broken through the forward lines. The normal distribution of the infantry to a position of this nature in the case of a division in the defence was one brigade to the outpost system, one brigade to the main battle position, and the remaining brigade as a mobile reserve, which might be located in the rear defensive position or wherever cover was available sufficiently near the main battle position for it to be brought into action for counter-attack purposes. This was the final form, at the end of the war, of a defensive position organized and occupied in depth, though naturally it was not everywhere attained in perfection since lack of labour often prevented its execution.

At the outbreak of war the engineers of a division, apart from the divisional signal company, consisted of two field companies. A proposal had been made a few years before to add a third company but this was rejected by the War Office. There had been in fact a counter-proposal to abolish field companies altogether and to substitute "pioneer" units, namely infantry with special training. It very soon became apparent that two field companies were quite insufficient

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for the large amount of work requiring to be done in modern war. In December, 1914, it was decided to increase them to three field companies per division, and the divisions at the front were reinforced by attaching to each a field company: of the Territorial Force, taken from the Territorial divisions training at home, who raised new ones to take their places. When the operations became more or less static, after the spring battles in Flanders and at Ypres, the increasing demands of trench warfare made it necessary to allot to each division a battalion of pioneers, obtained by conversion and special training of certain infantry battalions of the New Armies.

During the winter of 1914/15 it was discovered that the Germans were mining under our trenches in many places. To meet this menace, which the Army Council before the war had considered so negligiable that the training of field companies in this form of warfare had been reduced to almost. nothing, demands were made at the end of December, 1914, for special mining companies. Besides employment in mining under the enemy lines they were later of great value for the construction of deep shell-proof cover, and also, during the advance in 1916, for removing enemy booby traps and delay action mines. The divisional field companies were also in some divisions reinforced for some months in 1915 by attaching to them men of mining experience picked from infantry battalions recruited in the mining areas of Scotland, the Midlands and South Wales, for similar work. It was not until these special measures had been taken that deep shell-proof cover became available in anything like sufficient quantity.

The shallow and scattered trenches of the first autumn and winter were mostly executed by the infantry themselves with the field entrenching tool carried on the person. They were later deepened and widened also by the infantry, of whom it is recorded that they displayed " considerable lethargy and a marked disinclination to dig "*-no doubt owing to the inadequacy of their training before the war. When it was possible to undertake the deliberate execution of trenchwork the usual practice during the first year of the war was to allot to the work a strong infantry working party and a section of a field company R.E. This was a wasteful method, since the engineers were being employed on unskilled work when there was much skilled work required which could not be done at all without them. Another example of wasteful method was that for most of the first year all wiring was done by the R.E., though this is work which infantry can easily be trained to do, and the strength of the engineers was quite inadequate to do the large amount of this protection that was required. This was no doubt the reason why the wire on the British front was always so much weaker than that on the front of our French neighbours.

In the course of time, as the necessity for skilled work in making dug-outs, in mining, revetting, trench boarding, etc., became more and more pressing, the infantry were required to do the simple trenchwork without the assistance of engineers, except for laying out the trace and for supply of tools, etc., and also to wire their own front, and the engineers were kept to work which the infantry could not do. Even then the engineers required reinforcement by temporary working parties from the infantry for the unskilled work such as carrying up materials and the removal of spoil from mine galleries, etc., since the number of sappers available was insufficient to allow of their finding the labour for these. This work was much disliked by the infantry who believed they were being exploited for the benefit of the R.E. and called such work "R.E. fatigues." The arrangement was also not liked by the engineers, who had to work with unwilling and resentful infantry officers and men who had never been taught that the work in the execution of which they were required to assist was for their own security, and that it was not unreasonable to ask them to lend a hand in it. Later the practice was adopted of attaching an infantry working party permanently to 1.2.2.1

* Official History, 1915, Vol. I, p. 5.

each field company, with whom they were billeted and fed. This arrangement worked much better. The infantry soon learnt to do the work required of them and became efficient at it; they made friends with their R.E. partners in toil and were willing and contented. It was not very satisfactory to the infantry battalion commanders, who lost a considerable number of their rank and file for a long time.

Apart from this the organization of the technical troops was defective, owing to its having grown up without forethought. The pioneer battalions did excellent and most valuable work, but the divisional pioneer battalion was entirely independent of the C.R.E. and was supposed to, and generally did, receive its orders direct from the general staff. The latter no doubt as a rule acted on the advice of the C.R.E. in regard to the employment of the pioneers, but the want of a single controlling commander for all the technical work of the division was not conducive to efficiency. In practice the pioneers often to all intents and purposes worked under the C.R.E., who could thus divide the necessary tasks between them and his own field companies in the most convenient manner, but this arrangement, since the two commanding officers were of the same rank, and the pioneer C.O. sometimes the senior, was not an ideal one. The fact that it nearly always worked satisfactorily was due to the good sense and good will exhibited on both sides.

THE GERMAN ENGINEER AND PIONEER CORPS.*

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(INGENIEUR=UND PIONIER=KORPS.)

By Colonel (now Major-General) G. H. Addison, c.b., c.m.g., d.s.o., M.A., M.I.MECH.E.

INTRODUCTORY NOTE BY BRIGADIER-GENERAL SIR JAMES EDMONDS, C.B., C.M.G., D.LITT.

This account of the early history of the German Engineer and Pioneer Corps shows the neglect of military technics in Germany before 1914, and mentions, but does not sufficiently stress the contempt in which technical troops were held. A well-known result of this neglect was the inadequacy of the apparatus of what we call "Signals," and the break-down of the communication services in the opening phase of the operations in 1914.

A somewhat fuller account of the history of the German Engineers and Pioneers, with portraits and other illustrations, and stories of their doings in 1914-18, will be found in *Das Ehrenbuch der deutschen Pioniere* (Book of Honour of the German Engineers.)

The translation of foreign technical terms always presents difficulties, especially when words in our own and the foreign tongue are similar but have different significations. For instance, "Territorial" and "Brigadier" are French and English words but mean quite different things to a Frenchman and an Englishman. An artillery "regiment" in English and German means in the one case three batteries, and in the other two, three or four times that number. Now "Pioneer." and "Pionier" connote different things. Since I joined the German Section of the Intelligence Branch in 1899 I have always translated "Pionier" by "Engineer": a German divisional "Pionier" Company is the same as a field company R.E., with its full complement of tradesmen.

* (Reprinted from The R.E. Journals of June-September, 1930.)

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There is a danger in using the wrong word ; for a little before 1914 a reforming but ignorant General Staff officer—who was instrumental in preventing divisions having a third field company in 1914—advocated that field companies should be abolished and replaced by pioneers (British variety), because the German divisions had only pioneers. A purist would probably refuse to translate "Pionier" and print it in italics as a foreign word.

The Prussian railway and signal troops (there were slight variations in the different contingents) wore the same uniform (with black facings) as the Engineers, with a distinguishing letter of "E" (railways) and "T" (signals) on the shoulder straps or collar.

It is pointed out in the narrative that the manning of the trench-mortar units by the Engineers was a disastrous drag on its man-power. As the Engineers had developed the light and medium mortars for fortress warfare, they claimed as a right to be in charge of them in war—and a desire to fight in the . front line and neglect their technical work was one of the failings of the German Engineers. In an article I wrote in *The R.E. Journal* in, I think, 1896, after a study of the war histories of the German engineer battalions in 1870-1, I pointed out that in that war they had on every possible occasion fought as infantry when they ought to have been putting villages and woods in a state of defence and improving communications.

J.E.E.

INTRODUCTION.

"To enter the war (of 1914-18) at full strength from the start, Germany needed in peace 100 instead of 35 Pioneer battalions, and the war showed that this would have been feasible if all effectives had been called up. It would have been both cheaper and more businesslike to have carried the burden of this armament, than to lose the World War and be obliged to pay the consequences. If a prudent, calm German people, a far-seeing, wise Government, a vigorous resolute, supreme power had ensured the necessary increase in time, if only by two-thirds, the outcome of the war would have been very different, and victory won in 1914; it may even be that war would not have come at all. Not by weak-kneed pacificism, but by the doughty man-at-arms, by the strongest battalions is peace assured to a nation. And so all the self-sacrifice, all the devotion of the 50,000 Pioneer dead could not avert the Fatherland's doom. Once again has Segestes betrayed the people of Hermann."

"This is the end of the story ;

The Nibelungs' doom and despair."*.

This, freely translated, is the end of Lieut.-Colonel Augustin's story of the development of the German Engineer and Pioneer Corps during the last Great War.[†] It is an interesting and in some ways a surprising story. Germany entered the war with a Pioneer organization that provided three field companies to every two divisions, with no Army or General Headquarter reserves other than a few fortress Pioneer regiments which events might or might not make available for the field army. At the height of the struggle, there were still divisions with only a single field company and with over 200 divisions in the field only 9 Pioneer battalions (36 companies) remained unallotted to divisions. The story of the war, so far as the Engineer and Pioneer Corps was concerned,

• In A.D.9, Arminius (the Latin form of Hermann) led the people of South Germany in revolt against the Romans. In spite of the treachery of Segestes, who betrayed the plans to the Roman commander, the revolt was completely successful, and Hermann became the German national hero.

† "Die Entwicklung der Pionier-Waffe im deutschen Heere während des Weltkrieges," Von Oberstleutnant Augustin. Mittler & Sohn : Berlin. is one of a long hopeless struggle to make up for a bad start. Remembering the completeness of German pre-war organization, it seems incredible that the allotment of Pioneers to the field army in 1914 should have been proportionately so little greater, as regards officers even less, than what had proved necessary a century earlier. The long continued neglect, it might almost be called contempt, of the technical arm offers an interesting study of Prussian military psychology. The following pages are, however, designed as a plain story and not as a critical study. The original intention was to confine the story to the period of the Great War, but it soon became apparent that some knowledge of what had gone before was necessary to an appreciation of how and why things happened during the war. The result is a general history based on a number of German works which are tabulated at the end of this article; in addition, reference has been made to various official handbooks and publications in order to check and fill in gaps in the other works. It should be remembered that the original authors are all officers of the Engineer arm, and it is only natural that their views should be coloured by the peculiar conditions attaching to it. This is of some importance when expressions of opinion rather than statements of fact are in question. On all points in connection with the German Army, whether dealing with experiences of the past or lessons for the future, the opinions recorded are those of the original authors and not of the present writer, whose comments are generally confined to footnotes. The translation of the German word " Pionier" always presents difficulties. It has quite a different significance from "Pioneer" as understood in the British Army; but, for various reasons, the more usual translation "Engineer" would not be convenient. The plan adopted is to render literally "Engineer" for "Ingenieur," and " Pioneer " for " Pionier." Readers who are not already acquainted with the organization of the German Corps may find it helpful to glance at page 314 before reading further. Attention was first drawn to Lieut.-Colonel Augustin's work by Sir James Edmonds, to whom acknowledgments are also due for much valuable advice and help in the preparation of this paper.

EARLY HISTORY.

Pre-Napoleonic Period.

We usually begin the history of our own Corps with Waldivus Ingeniator, 1066, or at all events not later than Edward III's body of engineers, gunners and other artificers at Calais in 1346. There is no record of military engineers in Prussia until the second half of the 17th century when, under Frederick William of Brandenburg ("The Great Elector"), small parties of "pontoniers" and "miners" were attached to the artillery. The pontoniers were formed in squads of 10 to 15 men under a "bridge-master"; they had no bridging equipment, and it is evident that the artillery had to do most of the work. The greatest bridging exploit of this period occurred in 1689, when Frederick crossed the Rhine with 20,000 Brandenburgers over an improvised bridge. Frederick William I ("The Soldiers' King") formed the first independent company of pontoniers, but its strength was only 2 non-commissioned officers, I master and 20 men. He also introduced an equipment consisting of copper pontoons, each carried on a light wagon, with anchors, breastlines, boathooks, etc., but no superstructure. This company took part both in the Swedish War of 1718 and the French War of 1735. Like the pontoniers, the miners were at first attached to the artillery, only occasionally being placed under command of a miner officer. Both engineers and miners were employed at the Siege of Stettin in 1677, and this is the first record in Prussian annals of the use of "engineers" in a siege. In 1690, a regular miner company was formed, but of low strength, and with no regular status in the army.

At the end of the second Silesian campaign, Frederick the Great formed both

pontoniers and miners into separate corps, they had no fixed establishment, but were recruited as and when required for service. The copper pontoons were, at the same time, replaced by wooden boats, of a type that lasted until 1860, when the first iron pontoon was introduced. Frederick also organized a Pioneer battalion, but the losses of the Seven Years' War led to its conversion into Fusiliers.

At the beginning of the Napoleonic Wars, the Prussian Army, of roughly eight to nine Corps, had only two and a half weak pontoon companies; Austria had one battalion of four companies. Russia was better provided, and in 1812 had 6 pioneer battalions, and 20 pontoon companies with ample equipment, attached to the artillery. In France, until the Revolution, only artillery personnel seems to have been employed in bridging, but separate units were quickly formed which, by 1801, far outnumbered those of all the other armies combined, with the exception of the Russian. In 1809, Napoleon demanded two pontoon companies from Bavaria. These were the first technical troops to be formed in that country, and the Bavarian Pioneer Corps is their direct descendant.

Birth of the Prussian Engineer and Pioneer Corps.

In the general break-up of Prussia, both Pontonier and Miner Corps disappeared. When the army was reorganized in 1809-10, pontoniers, miners and engineers were amalgamated by Royal Decree into a single composite Corps. Various dates are given for the actual birthday of the Engineer and Pioneer Corps, which was at first composed of a Corps of Engineers (officers) and three companies of Pioneers, all that was allowed by the Peace of Tilsit. As first constituted, each company comprised in peace miners, sappers and pontoniers in the proportion 1:2:1. For war, the miners were to be formed into four fortress companies; the remainder into field companies (2 officers, 81 other ranks), consisting of two sapper and one pontonier sections. The distinction between fortress and field companies soon disappeared in the French War, siege operations during 1815 being almost entirely conducted by field companies not unlike the experiences of a hundred years later. By 1815, the number of companies had risen to 21, roughly one per division, and the strength of each company to 200. An Engineer officer was attached to each brigade headquarters, and with every Corps there was an Engineer and Pioneer Commander, with at least two other officers. These details are chiefly of interest for purposes of comparison with 1914.

The regulations of 1809 were signed by Scharnhorst, Gneisenau, Pullet, Boyen and Leithold. To Scharnhorst, as head of the reform commission, fell the executive duty of putting the reorganization into operation. He may be regarded as the first chief of the Engineer and Pioneer Corps, and so long as he remained in control the Corps was in close touch with the staff and the rest of the army. The final downfall of Napoleon left Prussia with restored confidence and strong forces. The army had so changed in size and character that drastic reorganization of peace establishments had to be undertaken; in particular, the need for much greater independence in the constitution of the principal arms was recognized. But the effect on the Engineer and Pioneer Corps was disastrous, for it was relegated to a subordinate position which soon developed into a state of complete isolation from the fighting arms. This condition of affairs, introduced in defiance of every lesson of the war, was to have a lasting effect not only on the Corps but on the whole technical service of the German Army.

The period that followed was marked by notable developments of science and progress of civilization in Europe. Population increased rapidly, finance flourished, hundreds of miles of road were bult, new industries sprang up, and Germany began to look for her place in the sun. Machine shops, first established

in Aix by the Englishman, James Cockerill, were copied in Germany by Von Hummel, Freund and Egells; and in 1826 the younger Krupp took over his father's primitive steel works at Essen, which in the course of a few decades were to outstrip all foreign competitors. But time was still to elapse before their importance to war technique was recognized. The Pioneers, one of whose duties at this time was to take over garrison guards when all other troops were on manœuvres, had little opportunity to interest themselves in scientific development. Their interest was first awakened in connection with railways and telegraphs. The army was slow to take either of them seriously, the general view being expressed in a paper written by the Chief of Staff, to the effect that it was impossible to contemplate the use of such new-fangled contrivances in war, where risk of failure so far out-weighed possibility of success. This was in 1836, and some years later the Chief of Engineers, General Aster, becoming alarmed at the growth of railways and their possible influence on the defence of fortresses, put forward a demand that no lines should be permitted to pass through a fortress, and that where they even approached its neighbourhood strict military control should be established and complete preparations for demolition made. The War Minister, Boyen, with more vision, laid emphasis on the strategical advantages to be gained by the defenders. When it is remembered that the term fortress covered many great towns, such as Cologne, it is not surprising that, in spite of military doubts, railway construction continued to follow the dictates of trade and of topography. Aster apparently took no steps to train technical troops either in construction or destruction.

The history of telegraphs is very similar, arguments of the same kind being advanced as to their possible danger to the army, and the necessity of control by the War Ministry. This led, in 1849, to the appointment of an Artillery Colonel as Director of State Telegraph Services under the Board of Trade, much to the chagrin of this department. The struggle to militarize state telegraphs continued throughout the next fifty years; but in the technical development of the service the Pioneers had no share.

The Corps of Officers.

In the earlier days of its existence, the officer corps went through many trials and tribulations. Starting with 37 trained Engineers in 1810, it had been built up by 1815 to a strength of 175, most of whom had no engineering training or experience except such as they gained in the war. The pre-war regulars went rapidly to the top, where they remained, causing complete stagnation in promotion ; for example, the Chief of Engineers became Major-General at the age of 43, while there were under him subalterns of 37 and Captains of 50. To add to the difficulties caused by post-war reductions, fortress construction and maintenance were formally entrusted to the Engineers in 1822. In the course of reorganization, there had been a great opportunity to broaden the scope of military and technical training of officers, but it was not taken; and in 1816, the study of tactics was cut out of the syllabus of the joint artillery and engineer school, as being unnecessary for technical officers. The chief aim of authority at this time was to get cheap fortress construction out of the corps, which became more and more divorced from the rest of the army. This applied equally to the Pioneer companies, and attempts to secure for them a share in field training and manœuvres met with stern condemnation as being a misuse of technical troops. 11111

General Army Reorganization of 1860-61.

In 1839, each army corps was provided with an organized column of entrenching-tool vehicles, and some years later a pontoon train was formed for every corps. No other developments occurred until 1860, when a general reorganization of the army began. In the course of this, Pioneer companies were grouped in battalions, each composed of one company of pontoniers, two of sappers, and one of miners, thus shifting the principle of unity from the company to the battalion. The total strength of a battalion was 18 officers and 482 other ranks, which was also decreed to be the war establishment. The battalion organization was based on purely peace considerations of command and administration; it was not adaptable to ordinary war formations, and led ultimately to many of the difficulties encountered during the Great War. However, the general scheme, which was carried out under Count Radziwill, a distinguished infantry general, as Chief of Engineers, seems to have been approved by the majority of Engineer officers at the time. The year's training of the battalion, as then laid down, was to consist of : recruit drills, 3 months; company training, 3 months; battalion exercises, 1 month; section leading and field exercise, 10 weeks; revetments, 3 weeks; afternoons throughout the year: in summer, swimming, gymnastics and general Pioneer duties; in winter, classes and schools.

A scheme was also started in 1861, of sending Engineer officers to foreign countries to study developments in fortification; the first to be dispatched went to Antwerp, Lille, Cracow and Lemberg; and two to England to study coast defences, especially the latest designs of steel-armoured casemates.

The Wars of 1864 and 1866.

The inherent weakness of the Pioneer organization became apparent in the campaigns of 1864 and 1866, during which all the heroism and devotion of the troops themselves could not make up for inadequate numbers and lack of cooperation. The need for properly organized technical services was also emphasized, particularly, in the Austrian War, for which both railway and telegraph troops had to be improvised. Four telegraph detachments were formed of state telegraphs personnel with a small nucleus of peace-trained Pioneers; three field railway detachments of civil railwaymen with a small Pioneer section attached to each; the whole under the orders of an Engineer officer attached to the Army Staff. After the war, a committee, set up by Von Moltke, severely criticized the ignorance displayed by higher commanders in their handling of the Pioneers, and also stressed the need for Engineer officers to have wider knowledge of the principles and conduct of field operations. It recommended that there should always be a senior Engineer Officer with the staff of every higher formation to advise the commander and convey his orders to the Pioneer troops.

The Franco-German War.

When the Franco-German War broke out in 1870, the general position had altered very little, although one important administrative change had been introduced. The Austrian War had shown the fallacy of separating pontoniers, sappers and miners, and shortly afterwards the battalion was reorganized in five companies: 3 field, I reserve and I fortress, all composed solely of "Pioneers." On mobilization, battalions were broken up; the commander joined the Army Corps Staff, single field companies were allotted to various formations, and the fortress companies to fortress garrisons. In all, 49 field and 39 fortress companies were mobilized. At an early stage, nine of the latter were diverted to the field army to reinforce the field companies, and during the advance nine more joined L. of C. for railway and general maintenance work; of the remainder, all but six were engaged in the Siege of Strassburg. Each peace fortress company had to mobilize three units, which were made up of 6% active, 6% reserve and 88% Landwehr personnel; 70% of them being fathers of families. Telegraph and railway detachments were specially formed, as in 1866. Other technical units comprised a field photographic section ; a mobile torpedo (submarine mining) detachment, designed to block the Seine at Havre; and two balloon detachments for which the personnel had been hastily trained with balloons obtained from England. The Corps of Engineer Officers was much below establishment all through the war, and was never made up, in spite of various shifts. Numerous examples are quoted of delays in operations and unnecessarily heavy losses on the part of the infantry, owing to the lack of technical help. However, on the whole, a rather brighter picture is painted than of the earlier wars; the gallantry of the Pioneer troops was recognized by the other arms with whom they often fought shoulder to shoulder; and legitimate hopes were raised that the future would bring wider recognition and increased opportunities to the technical arm.

Period 1871-1914.

These hopes were not realized. The very completeness of the victory led the German higher command to ignore shortcomings that had seemed so obvious to the Pioneers themselves, and such changes as were made had even a narrowing effect on the role of the Corps. Minor improvements were made in the constitution of a battalion; but railways were completely separated in 1875; and so, to all intents and purposes, were telegraphs, although the Chief of the Engineer and Pioneer Corps continued to exercise powers of inspection until 1899. For administrative purposes a regular chain of Fortress and Pioneer Inspectorates was created under a cabinet order of 1885; each inspectorate was headed by a Major-General, immediately responsible to the "Chief of the Engineer and Pioneer Corps and Inspector-General of Fortifications," who reported direct to the Emperor. All the officers of the inspectorates were Engineers, and the state of isolation of the Corps was thus perpetuated. It was the considered opinion of higher authority that Army Corps or other high commanders should not be saddled with responsibility for inspection or training of troops, with the technical details of whose work they could not be familiar.

The first real signs of improvement followed the appointment, in 1898, of another infantryman to be Chief of the Corps. This was Lieut.-General Baron Colmar von der Goltz, well known to all military students as the author of *The Conduct of War*, *The Nation in Arms* and other standard works. The appointment was made for the definite purpose of bringing the Pioneers into the army and, under his direction, single Pioneer companies were, at long last, permitted to take part in divisional and corps manœuvres; he also organized special Pioneer exercises on a large scale, which not only afforded valuable experience to the Pioneers, but served to arouse the interest of commanders and staffs. The Emperor became personally interested and drew up a comprehensive scheme for what he considered to be the correct distribution and training of divisional Pioneers; although it met with scant support at the time,* the organization that he proposed was very similar to what was actually approved although not carried out, in 1918.

The lessons of the Russo-Japanese War led to some improvement in the Pioneer reserve position; and to increased interest in fortress warfare; pioneer battalions in fortress areas were given special training in siege operations, and a scheme was worked out for the formation of Fortress Pioneer regiments in war. Finally, Army Corps commanders were given powers of inspection over the Pioneer troops in the district, though there is little evidence that they were exercised.

Von der Goltz's work was carried on by his successors, von Beseler and von Mudra; † the latter was responsible for the slogan, "*Pionier sein, hesst,* angreifen" (" To be a Pioneer means to attack").

• In the orgy of ship-building that was going on at the time, there can have been little money available for army increases. † Both Engineer officers and Staff College graduates. v. Beeler later commanded at

† Both Engineer officers and Staff College graduates. v. Beeler later commanded at the investment and capture of Antwerp; v. Mudra eventually commanded an Army in 1918, the only Engineer who did so.

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On the whole, although the period between 1870 and 1914 produced some improvement in minor details, the position of the Engineer and Pioneer Corps. in relation to the rest of the army remained generally much as it had always been, and the chief claim to recognition rested on their ability to take part in the infantry battle. Training in field works and bridging had reached a very high standard, and Lieut.-Colonel Augustin claims that, in spite of all difficulties, " better Pioneers the world never saw."

THE GREAT WAR PERIOD.

General Summary of the Position in 1914.

It will now be convenient to summarize in detail the position of affairs just before the outbreak of the World War.

The Engineer and Pioneer Corps comprised :---

(i) A Corps of Engineers; officers only,

(ii) A Corps of Fortress constructors, composed of :

(a) Fortress Corps officers.

(b) Fortress Corps officials (wardens).(c) Foremen of Works.

Both (b) and (c) being recruited from non-commissioned officers of Pioneers.

(iii) A Corps of Pioneers.

All officers started their career in a Pioneer battalion ; and, after a minimum of 21 months' service, were sent to the technical school, where they specialized. All remained on one list for promotion and, in theory, were interchangeable ; but, in practice, having once specialized they were only changed over in exceptional circumstances. The whole of the men were trained in the Pioneer battalions and only non-commissioned officers were eligible for transfer to the fortress branch. The normal period of service was two years, of which the first was devoted almost entirely to infantry training. No trade standards were laid down but, as far as possible, suitable men were selected from civil life.

The German Empire was divided into 25 Army Corps districts.* Two Pioneer battalions were allotted to each of 10 Corps, one battalion to each of the others, making a total of 35 battalions. With the exception of the III Corps, of which the headquarters was at Berlin, each of those with two Pioneer battalions included an important fortress, where the Pioneers were invariably quartered. The battalion consisted of 4 companies, each organized in 3 sections; in addition, 26 battalions had a searchlight section attached. Peace establishment of the battalion: 24 officers (including attached) and 644 other ranks; of a company, 5 officers and 152 other ranks. Total peace establishment of the Corps, in round numbers, 900 officers and 20,000 other ranks.

As regards other technical services with which the Engineer and Pioneer Corps was not concerned ; railway, telegraph, balloon and aviation troops were directly under the Inspector-General of the Military Communication Service : barracks and military buildings, not coming under the head of fortifications, were in charge of the Barrack Construction department, a branch of the Intendance; Survey was a function of the General Staff.

For war, a battalion was expected to form three to five field companies, one or two being permanently attached to each division and one kept at disposal of the Corps commander; one Corps and two divisional bridging trains.

-* The organization of the infantry was :-----

1 Corps=2 Divisions.

1 Division = 2 Brigades, but 6 Divisions had 3 Brigades each. 1 Brigade=2 Regiments, but 5 Brigades had 3 Regiments each. I Regiment=3 Battalions.

- I Battalion=4 Companies.
 - There were also 18 independent Jaeger Battalions.

Total battalions=669.

Certain battalions had to mobilize detachments, each of 1 officer and 33 other ranks, to accompany cavalry divisions; also field and fortress searchlight sections. Others were to be formed into fortress regiments of two or three battalions, each with a siege train. The battalion staff (2 officers) joined the Army Corps headquarters.

The war establishment of a company was 6 officers (includes 1 medical officer and 1 paymaster) and 262 other ranks, organized as for peace in a headquarters and 3 sections. The transport consisted of three 2-horsed and one 4-horsed store wagons, 1 baggage wagon, 1 supply wagon, and 1 field kitchen; the last three being all 2-horsed and forming the 2nd line transport. There was also 1 pack-horse.

Both in peace and war, all transport of Pioneer units was provided with horses and drivers from the Train; so the personnel belonged to another branch of the service.

General Mobilization, August, 1914.

When army mobilization actually took place all units were brought up to war establishment, and additional units were raised from surplus men at the depots. These units combined to form Reserve Corps, Landwehr and Ersatz brigades. The majority of the reserve corps went straight into the field; fresh corps were rapidly formed, and early in 1915 the reorganization of four-regiment divisions on a three-regiment basis was begun, by which means extra divisions were gradually added. A total of 93 divisions were actually put into the field in August, 1914, which had increased by March, 1915, to 135; at the end of 1916 there were 200, and the highest point, just over 230, was reached in June, 1917, and maintained for just a year. These details are needed in order to follow the course of the Pioneer development.

Pioneer Mobilization.

Immediately mobilization was ordered, each of the Pioneer battalions was duplicated ; the first battalion consisting of Nos. 1 to 3 regular companies, and the second of No. 4 regular and 2 reserve companies. Nine battalions labelled in peace as "fortress" formed themselves into Pioneer regiments, complete with regimental staff, and were earmarked for employment as army troops; and nine reserve battalions were detailed to fortress garrisons. In the case of all other battalions, mobilization again spelt disintegration. The commander and headquarters went off to various corps and other staffs, while the companies were allotted, either singly or in pairs, to divisions. Landwehr and Landsturm companies were raised to accompany corresponding formations; also a number of Ersatz companies on a low establishment. Altogether from the 140 peace companies with a strength of some 20,000, were produced 379 companies of all sorts with a total strength of 80,000. Other units that were immediately formed comprised some 100 fortress and 25 field searchlight sections; a heavy bridge train for the Rhine; 25 Corps and 70 divisional bridging trains, with nearly 6,000 m. length of equipment ; 9 siege trains ; and 9 cavalry sections. So it will be seen that half the divisions that took the field had only a single field company, and about the same number had a searchlight section. Several of the reserve divisions and nearly all the reserve corps were short of a bridging train. There were no Pioneer corps troops. Pioneer regiments on a scale of roughly one per army were available as army troops. The Chief of the Engineer and Pioneer Corps with his Staff joined General Headquarters; and the various inspectors were attached to Army Group and Army Headquarters, all being replaced at home by officers of the reserve. It must be said that their position was in no way improved by mobilization; they still remained outside the normal staff organization and the Chief continued to report direct to the Emperor. When mobilization was complete the total Pioneer strength amounted to roughly 120,000.

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Results of breaking up Pioneer Battalions on Mobilization.

The process of mobilization proceeded smoothly and punctually in accordance with plans that had been worked out in great detail and revised every year. But the complete break-up of the peace organization could not fail to have serious results. No Pioneer officer or staff was allotted to divisional headquarters and the field company commander, or the senior where there were two companies, had to try to perform the dual role of staff officer and company commander. For the most part, divisional commanders ignored them altogether, with the inevitable result that ill-timed, inadequate, or in some cases no, orders were received by the field companies. Three early examples are quoted, of which the third has a particular interest :—

- (i) During the advance of the 34th Infantry Brigade group against Liége, 5th to 8th August, a delay of 24 hours occurred at the Meuse before bridging started, although three field companies and two bridge trains were at the disposal of the brigade commander. Failure to keep the Pioneers informed and delay in sending them orders involved the brigade in an unsuccessful attack and heavy casualties, the delay in bridging having removed the element of surprise and left no time for proper reconnaissance.
- (ii) The advance of the XVI Corps was delayed for a whole day on the Meuse below Verdun, in August, 1914, owing to the failure of the divisional generals to give timely orders to their field companies, although the Pioneer commander at Corps Headquarters had made all arrangements for the necessary equipment to be at hand.
- (iii) On the 8th September, 1914, von Klück ordered the IX Corps to detach a force to hold the line of the Marne against the advance of the British, and to destroy the Marne bridges. Von Quast, Commander of the IX Corps, detailed for this task a mixed brigade under Major-General Kraewel, to which one field company was allotted. The brigade reached Montreuil-Aux-Lions, 5 km. from the river, during the night, but the Pioneers never arrived, and apparently no orders reached the company.* The brigade was tired out, but there would still have been time during the morning of September 9th to destroy the bridges about La Ferté, which fell into the hands of the British later in the day. There was no senior Pioneer officer with any of the formations concerned, and even if the one field company had turned up, it would have been quite inadequate to deal with the 10 road and 7 railway bridges in the area.

Liaison between the Pioneers and the cavalry seems to have been better, though the Pioneer detachment with a cavalry division was deplorably small. In example (i) some cavalry on the right of the 34th Brigade crossed the Meuse on both improvised and equipment bridges without delay. In example (iii) the 2nd Cavalry division on Kraewel's right destroyed the two road bridges at La Ferté, though they left the railway bridge east of the town standing.[†]

Effects of Low Peace Establishments.

Further difficulties were introduced by the low peace establishment, which led to over-dilution with reservists and elderly men, with serious effects upon efficiency. Many of the men were physically unfit for the hardships of war service; they were also insufficiently trained in the more recent developments of Pioneer technique.

• The German official monograph on the Marne says, " for reasons not now for certain discoverable the orders never reached it." See p. 287 of the Army Quarterly, January, 1930.

† Cavalry bridging equipment and vehicles actually belonged to cavalry regiments and not to the Pioneers; cavalry regiments also carried a quantity of explosives in their own transport. Shortage of bridging trains produced more complications, and delays in crossing the numerous French canals and rivers were frequent. The IX Corps is quoted as having lost 12 hours before crossing the Oise and Oise Canal at the end of August, owing to insufficient equipment, the corps bridging train having apparently had to be shared with the IX Reserve Corps.

Much the same state of affairs existed in connection with fortress mobilization. Plans had been worked out in great detail beforehand; but lack of touch between the higher command and the Engineers and Ploneers, and also failure to provide adequate reserves of tools and materials, led to much confusion and delay. In the event, no German fortress came within the sphere of active operations; had events turned out differently, extraordinary crises and breakdowns might have occurred.

Reorganization during the Course of the War.

- Three separate problems had to be dealt with during the war :-
- (a) the provision of newly-formed Corps and Divisions with Pioneer units;
 (b) increase of the number of Pioneers in every division, so as to improve the ratio of Pioneers to infantry;
- (c) creation of additional units to cope with the new weapons and technical methods that grew up with the war.

To a great extent, all three had to be faced simultaneously, and as will become apparent, the claims of (a) and (c) continually conflicted with those of (b), which, in the eyes of the Pioneers, was of first importance. Floods of keen but raw recruits streamed into the depots,* there to be first trained individually, and then kneaded into new units. At the same time the heavy losses in the early battles raised a continual cry for reinforcements; while scarcely less urgent were the demands of civil industry for tradesmen. Amid these conflicting claims nothing could be done to help the original divisional Pioneers, on whom increasingly heavy calls were made. The shortage was just as bad among the army companies, many of which were tied up in the attack of certain fortresses, notably Maubeuge, Longwy and Antwerp. The remainder were quite insufficient to deal with all the semi-permanent bridging wanted as the advance went on.

Example of Overwork of Field Companies.

A typical case of the strain imposed on divisional companies is given. The 1st (Reserve) Company of the 3rd Pioneers was the only company with the 6th Reserve Division. About 6 p.m., on the 4th October, 1914, after several days of continuous fighting, they reached the River Nethe, over which assault bridges of improvised material were thrown. These had to be launched under heavy fire, and the Pioneers crossed them in company with two battalions of the 35th (Reserve) Infantry Regiment to the assault of Lierre. As soon as the southern part of the town had been cleared they repaired the existing road bridges under artillery fire, and then took part in the storming of the northern area. Here the attack was held up by barricades and broken ground. During the night the divisional bridging train came up and the company threw pontoon bridges over the two southern branches of the river, whereby artillery was enabled to advance and deal with the barricades. At 7 a.m. next morning, assault bridges were made south-west of Lierre for a battalion of the 26th (Reserve) Regiment. The infantry hesitated to advance over the water-logged meadows, so the Pioneers led the way, cleared the opposite bank by rifle fire, and then launched the bridges, by which the position was stormed. In Lierre the heavy traffic over the bridges necessitated constant repair work, and an additional bridge was built in the south part of the town over which, in spite of continual damage and interruption by enemy fire, reinforcements of infantry and artillery were able to go forward.

* Lt.-Col. Augustin says that, whereas France had in peace 2.1% of the population with the Colours, Germany only had 1.2%; a very poor proportion of the possible effectives.

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By this time the company had worked and fought continuously for over 50 hours without a single pause ; neither rest nor relief was possible.

Beginning of Trench Warfare,

When, after the battle of the Marne, the war gradually took on the appearance of a siege, new demands were quickly made on the Pioncers. The fighting arms were quite unprepared for these conditions and depended more than ever on technical assistance. Fortunately, some of the fortress Pioneer battalions had taken part in extensive siege manœuvres during peace, and the field companies soon learnt the tricks from them. Many divisions improvised infantry Pioneer companies, but this only left the regiments themselves the more helpless and increased their calls for skilled assistance. The first trench mortars and flameprojectors came into use, and were manned by personnel withdrawn from Pioneer units. It is not surprising that the autumn and winter of 1914 passed away without any improvement in the ratio of Pioneers to infantry.

Developments during 1915.

Further delays occurred at the beginning of 1915, when bridging trains had to be raised for the new formations that were created by withdrawing fortress troops from the Eastern Front. Then mine warfare came into prominence, for which fresh companies were continually needed. A new form of Pioncer assault tactics in conjunction with flame-projectors was introduced in the Argonne by Licut. Beumelberg, after whom it was named,* and this was followed by an increase in, and proper organization of, flame-projector troops. In March, a special "assault " detachment was formed, consisting of headquarters, 2 Pioneer companies, and a gun section with 20 3.7-cm. guns; and at the same time the 3rd Guard Pioneer Battalion was organized as a flame-projector unit, with headquarters, four companies and a workshop detachment. The assault detachment tried out new methods of attack and, at first, made much use of portable shields and body armour; the personnel were employed both as instructors of the infantry and as the nucleus of specially selected assault parties. At last, in April, sufficient new units became available to provide every division in the field with two field companies. This was only a beginning. The need for field companies on a scale of one per infantry regiment was generally recognized, although an alternative proposal to increase the establishment of existing companies from 250 to 300 men met with some support. Both plans were rudely checked by the scheme of army reorganization, by which all divisions were gradually reduced from four to three regiments; the regiments thus released being grouped into fresh divisions, which again had to be furnished with technical units.

At the beginning of this year, intensive experiments had been carried out with disinfection and breathing apparatus (Desinfektions-gerat und Luftflaschen) by two special Pioneer companies under Colonel Peterson; and in April and May, the 35th and 36th Pioneer Regiments, each of two 3-company battalions, were established as gas-warfare troops.

About the same time the first Pioneer park company was formed in the Sixth Army area; eleven more for the other armies following at intervals during the year.

In June, the first detachment of Pioneers, equivalent to about one company, departed for Turkey.

For the Austro-German crossing of the Danube in October, a Pioneer "landing" company, for which an establishment had been prepared in peace, was brought into being, and was provided with special landing equipment based on English experiences.[†] A Pioneer "ferrying" company was also formed for the rafting operations at Semendria.

• The German official monograph Argonne says, " In the rolling-up of enemy trenches, which was later developed as a special method of fighting, Lieut. Beumelberg (Walter), 2/Pi/30, early exhibited an exemplary mastery."

† Presumably at Gallipoli.

During the autumn the increase in enemy air activity required a systematic organization of anti-aircraft troops, and the Pioneers were called on to man the anti-aircraft searchlights; the first detachment, equipped with 90-cm. lights, was assembled in September.

All this time, trench-mortar units were in a constant state of reorganization and expansion, and their requirements brought a steady drain on the Pioneer resources.

Complaints as to the recruiting position in Germany, and delays in sendingreinforcements, led to a demand for field training depots at the front. At first the War Ministry objected strongly, fearing lest unauthorized units might be formed and Pioneer reserves used up too quickly. However, in October, permission. was granted to establish a Pioneer training depot in the XVI Corps area, where the personality and experience of the Commander (Gen. von Mudra, late Chief of the Eng. and Pi. Corps) provided a guarantee against misuse, and where the conditions in the Argonne offered peculiar facilities for training. Thus the year 1915 did produce a certain measure of improvement in the unsatisfactory position created by inadequate peace establishments; it was, however, no more than a meagre approach to what was really needed.

1916.

During 1916, the process of forming new divisions went on simultaneously with the reduction of four regiments to three within the division. The number of divisions in a corps was increased, and the heavy casualties and need for relief of exhausted divisions had the effect that the divisions in a corps were constantly being changed. This only served to accentuate the difficulties of the Pioncer situation, and to increase the urgency of continuity in technical control. The result was that selected Pioneer officers were gradually detailed by G.H.Q. to take command of all the Pioneer units in divisions, and were given small staffs for the purpose. The normal organization of divisional Pioneers began to be recognized as: headquarters, two field companies, searchlight section, trenchmortar company, bridging train. Parks, or other special units attached to the division were put under the Pioncer commander. Some divisions, particularly at Verdun and on the Somme, improvised additional units ; for instance, the 56th Division at the Mort'Homme, in July, formed a third field company by taking one section from each of the others, putting the senior subaltern in command; this division had found it necessary to form a mining company from each infantry regiment some time earlier. Even six units were not enough at the height of a battle, and eight companies (field and mining) were employed in mining operations under the Pioneer commander west of Givenchy-en-Gohelle during When mine warfare reached its zenith, between 40 and 50 special August. Pioneer companies had been formed, besides a number of improvised units.

During phases of the Verdun fighting it was found necessary to allot a field company to every battalion, although the infantry were better trained in field works than ever before. In fact, it is said that the infantry-man at this time would rather have been without his rifle than his spade.

The drain on Pioneer reserves continued to be very severe all through this year; for, in addition to the heavy battle losses, trench mortar and flameprojector units were still further added to, and a number of fresh searchlight units formed. Two Pioneer recruit training depots were established behind the Verdun front; also one in the Balkan theatre, which was called for, not only by the distance, but by the need of allowing reinforcements to become acclimatized.

Other developments during this year were a "Water Transport" (No. 310) Pioneer Company, used for canal traffic in Alsace-Lorraine, under the director of railways; the appointment of an Inspector of Gas regiments; and the inauguration of a Pioneer training establishment at Maubeuge, to which resting battalions were sent for refresher courses, or for special instruction and training in schemes for the break-through. 1917.

The year 1917 was ushered in by an administrative measure that was long overdue. On January 24th, formal approval was given to the establishment of a Pioncer battalion headquarters with every division. In many divisions there were still only one or two field companies;* unfortunately, also, some divisional commanders did not yet know how to make use of the new organization. But, at all events, divisional Pioncers had recovered the tactical unity of which mobilization had deprived them. At the same time, Pioneer staffs with Corps Headquarters were regularized; but the position here remained unsatisfactory, for only one staff officer (a captain) was allowed. Junior officers could not be expected to possess either the authority or the experience that was needed, and during the summer they were replaced by Pioncer licut.-colonels.

Further developments occurred during the first half of the year. The recruit training depots had proved so successful that they were established behind every army. A Pioneer officers' training school was opened at Maubeuge for the Western Front, and at Kovno for the Eastern. Searchlight detachments were reorganized in consequence of the introduction of a portable electric light, which was so much simpler in use than the delicate oxy-acetylene pattern, that it became possible to hand it over to the fighting arms, only retaining small care and maintenance parties of Pioneers.[†] A special trench-warfare Pioneer park organization was set up, comprising four battalions, each of three companies, a trench mortar park inspectorate with five companies and a trench mortar instructional detachment. The role of this organization was to administer the vast quantity of trench-warfare weapons in corps and army parks, to inspect and test supplies before delivery from civil firms, and to run the newly-built home depots. Finally, Pioneer units were raised to accompany the so-called "Pasha" expeditionary corps to Asia.

The development of the Corps had now reached its zenith. Increasing difficulties in finding reinforcements compelled the War Ministry to issue instructions for retrenchment towards the end of September. The abnormal increases in trench mortar units had drained the Pioneer reserves. L. of C. and home establishments were combed out, all fit men being replaced by those unfit for service. But such measures no longer sufficed. Shortage of men and even more noticeably of horse-flesh brought about a reduction of Pioneer establishments before even the process of building up could be completed. Divisional Pioneer battalions were to remain short of their three companies. " The Nibelungs' hour of doom had struck." Divisional and Corps bridging trains were handed over from Pioneer battalions to ammunition trains and columns, whereby the Pioneer detachments were saved to the benefit of the Pioncer reserve. A little later, 7 Corps and 24 Divisional bridging trains were disbanded, and reductions made in many others ; there remained 14 Corps and 30 divisional trains at the disposal of G.H.Q., 22 Corps (5 without horses), and 79 Divisional, under Corps and Army Headquarters. The result of these measures was that the equipment, insufficiently cared for by non-technical personnel, steadily deteriorated ; and the Pioneers, with restricted opportunities for practice, lost their skill in the technique of bridging ; so that, before the 1918 offensive, selected Pioneer units had to be put through intensive courses of training. But, worse still, Pioneer battalions lost the bridging vehicles on which they had been accustomed to depend for the forward transport of trench stores and tools. Night after night drivers and teams had given devoted service

* A British G.H.Q. Intelligence pamphlet dated Jan./17 says: "The number of pioneer companies (exclusive of mining companies) now formed allow of 3 Pioneer field companies for every German division in the field." This was never true, and only approximately so if all available companies had been allotted to divisions, to the complete exclusion of Army Troops, L. of C., etc. The confusion no doubt arose from the German universal ("Einheits-") Pioneer Company system.

 \uparrow Apparently the small type was taken over by the infantry and the heavy (A/A) by the Air Force, though this is not actually stated.

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under conditions of indescribable difficulty and danger; now they were no longer available.

1918.

The process of retrenchment gradually spread. In February, three divisions had to be disbanded ; in June, one ; in August, nine ; in September, ten ; in October, four. The Pioneers of these 27 divisions were retained for the most part as G.H.Q. reserves, only a few companies being used to fill existing gaps in other divisions. The Pioneer staffs were placed in charge of sectors of rear line construction. The total number of Pioneer units was, therefore, not decreased ; but, in order to maintain them, the establishment of companies had to be reduced to a nominal 220. Reductions in the infantry could, to some extent, be offset by increases in the number of machine-guns ; but it was very difficult to find means of replacing Pioneers by machines. No. 421 Pioneer (boring) Company was formed in February, No. 422 (compressed air) Company in April, and No. 423 (mechanical trench-digger) Company in July; but subsequent events put an end to experiments of this kind. There is little more to be said. Three extra gas battalions were formed in 1918, making a total of seven active and one reserve battalions under the commander of gas troops. Finally, trench mortar companies were transferred from Pioneer battalions to infantry regiments, but too late to bring any relief to the Pioneers.

In all, during the war, 425 Pioneer companies of various kinds; 176 searchlight sections; 42 divisional, 17 Corps and 11 Army bridging trains; and 4 Pioneer siege trains were newly formed. The number of Pioneers in the German Army rose to roughly 170,000, all ranks, with 8,000 m. length of bridge equipment. Thus the total strength was more than doubled in the course of the war. None the less, the strength within divisions never arrived at what had been asked for, had been shown to be necessary by technical experts before the war, and was proved to be absolutely essential by the war itself. A further 240 companies were required, which means that the total Pioneer strength should have risen to 220,000; *i.e.*, three times the mobilization strength.

Technical Services Not Belonging to the Engineer and Pioneer Corps.

Some mention must be made of certain units which were outside the Pioneer formations and did not draw their personnel from the Pioneer depots; although their work was certainly technical, and ought to be recognized as functions of the Engineer and Pioneer Corps in any future organization.*

The first to be considered are the electrical detachments. Improvised units were formed by some armies in the winter of 1914-15, to take over captured power stations, from which power for workshops and light for billets were distributed about army areas. Later, light was also taken up into the front line. In places, power was used to electrify wire obstacles, but, with the great increase of artillery fire, these were abandoned. Forty-one companies and 76 independent detachments had been formed by March, 1917, when official sanction was given for a regular electrical unit in every army. The commander of this unit belonged to the General Staff of the Army, which led to the interests of the fighting troops being subordinated to those of back areas. In the Seventh Army, sections were attached to divisional and corps Pioneer units, an arrangement that worked well. Personnel of searchlight sections, set free by the reorganization referred to earlier, proved especially apt for this work.

Labour Battalions.—At the beginning of the war, labour detachments of Landsturm were formed into military construction units of various strengths and designations, and distributed among the German fortresses. Numbers of them were soon sent to the front for work on rear positions, roads, and billets; and later into the forward zone, where they performed varied and arduous tasks; in fact, within an army area, they came to be regarded as universal

* It must be understood that in this and similar cases the opinion expressed is that of the German author.

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constructors, providing for needs that varied from mineral water factories to heavy steel shelters. In the spring of 1915, these mixed formations were reorganized into regular labour battalions, of which there were ultimately 217. When the construction of rear positions was systematically undertaken in 1915 and 1916, directing staffs were formed of officers from all arms, principally staff, Pioneers, and artillery. A number of battalions were allotted also to divisions and were generally placed under the Pioneer commander. The tremendous achievements in field fortification during the latter half of the war owed much to this measure, and to the heroism and devotion of the men of the labour battalions, whose work, carried through without proper officers, organization, or equipment, can never be forgotten by the specialist—the Pioneer.

Railway Units.—Finally, a word about railways.* The permanent peace establishment was three regiments and one Bavarian battalion, the latter always retaining close connection with the Bavarian Pioneer Corps. Every modern means of locomotion and transport was employed in the war. Railways played a part of great tactical as well as administrative importance. Without them, Tannenberg, the Masurian Lakes battle, the breaks-through at Gorlice and on the Isonzo, the campaigns in Serbia and Rumania, and many great battles on the Western Front would all have been impossible. The mobilization scheme provided for 56 construction companies and 4 auxiliary battalions. These proved to be quite inadequate, and very early steps had to be taken to mobilize the personnel of the civil railway and bridge-building industries, whereby a veritable technical transportation army was created. At the end of the war, there were 164 construction companies of various categories, 125 operating companies, 71 labour companies, besides a large number of light railway, ropeway and special units, and γ armoured trains.

LESSONS OF THE GREAT WAR.

Reasons for Shortage of Divisional Pioneers.

If the question is asked, why was it never possible to furnish divisions with the Pioneer units that were recognized as essential, the answer can be given in two words : trench mortars. The Pioneers were the protagonists of this weapon. During siege manœuvres in 1913, a special Pioneer trench mortar troop had been organized, and the use of mortars in the infantry mobile battle practised ; so it naturally fell to the corps to sponsor the weapon in war. But once it had become a going concern, the whole business should have been handed over to the infantry and artillery ; and this was, in fact, discussed by the Higher Command from 1916 onwards. The Pioneers themselves were loth to give it up, and the staff feared lest development on sound lines should be checked. Consequently, it was not until the complete exhaustion of Pioneer reserves made it unavoidable that the transfer was ordered; and then it was too late. The organization of trench mortar units underwent many changes. At the period of maximum strength of the army, the trench mortar company comprised three sections; one heavy (4/25 cm.), one medium (8/17 cm.) and one light (6/7.5 cm.), with an establishment of roughly 200. The total strength in the field was thus between 40,000 and 50,000, almost exactly the numbers required to complete every division with three field companies. From first to last, some 200,000 Pioneers and 17,000 mortars passed through these units.

Correct Proportion of Pioneers to Other Arms.

Opinion as to what was the correct proportion of Pioneers with an army had pretty well crystallized by the end of 1916. The Commander of the German First Army, General Fritz von Below, in a paper dealing with the experiences

^{*} This is not referred to by Lt.-Col. Augustin, but in the historical section of "Der Pioneer" there is a brief summary dedicated "To the memory of the German railway troops," which is of interest. As already explained, although originally one with the Pioneers they had been entirely independent since 1875.

of the Somme Battle, dated January, 1917,* gave his views in full. A little later; the General of Engineers and Pioneers at G.H.Q. issued a detailed scheme, which embraced and amplified Below's proposals; to which he appended a suitable peace establishment. In July, 1918, the War Ministry officially specified Pioneer requirements based on the experiences of the war, as follows : A number of higher staff officers (Generals); with every Army Group, Army, or Army Corps, a Pioneer regimental commander and staff ; for every division of three regiments, a Pioneer commander and staff, one battalion of four companies, a field searchlight and anti-aircraft searchlight section, and a divisional bridging train; to every three divisions, one Pioneer battalion as G.H.Q. reserve ; to every six divisions, one Pioneer park company, and a Corps bridging train ; for each cavalry division, a light Pioneer detachment with light bridging train; as special G.H.Q. troops, one Landing Company, three Gas Regiments, and one Flame-Projector Regiment. The corresponding peace establishment was laid down as : 64 Pioneer regiments (one per division)† comprising 128 battalions, one Gas Pioneer Battalion, one Flame-Projector Pioneer Battalion, an experimental and instructional regiment of two battalions. Except that the Pioneer general proposed a rather larger proportionate peace establishment, there was little difference between his scheme and that of the Ministry. Owing to the result of the war, nothing, of course, came of these proposals. Lieut.-Colonel Augustin sums up by saying that nothing can alter the following conclusions : that a large modern army needs Pioneers in far greater numbers than anything contemplated by Germany before the war; that the peace strength must be large enough to ensure that existing formations do not have to be broken up on mobilization; that units should be organized in the largest possible formations, at least battalions.

Need for a Technical Head of Pioneer Units.

The war proved conclusively the importance of a technical chief of Engineers and Pioneers in the field, and the absolute necessity of regularizing his position at G.H.Q. The Minister of War, von Stein, the Chief of the military cabinet, Freiherr von Lynke, Ludendorff and Hindenburg, all at different times expressed their conviction on these points. But it was only towards the end that official action was taken to improve a state of affairs that had been incredibly bad. Relegated to the 2nd echelon, attached to the Chief of the General Staff but with no recognized position or authority, the Chief of the Engineer and Pioneer Corps, in the early days of the war, remained in ignorance of the progress of events and with no indication of the intentions of the higher command. Experience proved the need for technical advice and co-ordinating authority, which were gradually made use of by the General Staff, to their own great benefit ; in particular may be quoted : Verdun, the "Alberich" (March, 1917) retirement, the 1918 spring offensive, especially on the Marne and at Rheims, the construction of the Mense position, the final Rhine crossing.

Pioneer Stores and Tools.

In 1914, each field company had four tool wagons, carrying wood- and metalworkers' tools for improvised bridging and for demolition work. Three wagons were loaded identically, each carrying the tools of one section, while the fourth held the company reserve and special articles. Various bridging tools and accessories were held in divisional and corps bridging trains; the latter also carried a reserve of explosives. During the war, extra vehicles were added for trench warfare contrivances such as grenades, lights, signals, etc. The original technical vehicles with companies proved unsatisfactory and were replaced by G.S. wagons, otherwise the organization worked well. But care had to be taken not to increase the first line transport of field companies unduly, six tool vehicles

• A translation was issued soon afterwards by British G.H.Q. (Intelligence).

† An interesting indication of the size of post-war Army that was then being looked for.

per company being regarded as the maximum. Horses for every Pioneer officer in the field proved indispensable for reconnaissance work; equally necessary was a light lorry with every divisional Pioneer battalion H.Q.

Explosives, Grenades, etc.

The supply of explosives presented difficulties owing to shortage of certain raw materials, and all sorts of makeshifts had to be adopted. The chain of supply in mobile operations was: munitions trains to artillery munition columns; thence to corps bridging trains and so to field companies. In trench warfare, supplies were sent to companies direct from Pioneer parks. Economy in use was insisted on, but for certain operations (e.g., "Alberich") requirements were so large as to necessitate the formation of special explosives columns.

Much difficulty was experienced in producing suitable lights and signal devices, and the end of the war left a number of points undecided. Hand-grenades early assumed importance, as was to be expected from the experiences of the Russo-Japanese War. A small supply of ball (Kugel) grenades had been stored in German fortresses, and immediately war broke out the Pioneers began to experiment with new types. The stick (Stiel) grenade was considered to be the best produced during the war, and it was copied by all other armies.* It was noteworthy that the British and French preferred the "egg" grenade, designed for defensive use from under cover, while the Germans and Russians favoured the more handy "stick" type, and employed it offensively. Consumption by all arms of the German Army reached the astounding figure of 9,000,000 in one month, a large proportion of which must have been wasted. Every unit carried hand-grenades in its first line transport ; supplies were consigned direct from home to Pioneer parks, and thence to the troops. In the great 1918 advance, divisions were followed by light Pioneer columns carrying supplies of grenades, which were replenished from special columns ordered up as necessary by G.H.Q.

Rifle grenades, which were designed by the Engineer Committee in the early days of the war, came into some notice again in 1918; but there were always difficulties in manufacture, mainly as regards raw materials. A stick-bombthrower became popular, but was unsuited to mobile operations and was superscded by the light trench mortar.

The flame-projector diminished in importance towards the end, the heavy type being immobile, while the light type had a short range and small effect. This weapon, of which the origin dates to pre-war days, has its definite uses as a close-combat accessory.

Bridging Equipment.

The pontoon equipment proved highly satisfactory and met all requirements. The galvanized steel pontoon was of two types; uni-partite, weighing 1,102 lb.; bi-partite, weighing 661 lb. and 683 lb.; the buoyancy of the complete boats being identical. Corps bridging trains were equipped with the former, one boat and one bay of superstructure being drawn by a six-horse team. In divisional trains, a half pontoon and half a bay of superstructure were carried on four-horse vehicles, which were as mobile as field artillery. The value of the extra mobility was, however, neutralized by the delay caused in joining up the two portions of the boat; the heavier vehicles of the Corps train always came up in time, and, with their complete pontoons and bays, were much to be preferred. I in normal bridge ($3\frac{1}{2}$ -ton total load, but no lorries) the baulks were gunwale loaded on four boats; in "heavy" bridge (11-ton total load; single line metre-gauge railway) on six boats, with extra baulks and double chessing. A strength-ened four-boat bridge to carry 5-ton total (empty 3-ton lorries) could be made by doubling the baulks under wheel tracks. The cavalry had a special steel boat

* Lt.-Col. Augustin's views on these points are open to question.

† The bi-partite boat was apparently discarded after the War.

equipment* which was a failure, mainly owing to the high centre of gravity of the vehicles, which caused most of them to break down and be abandoned. A special heavy equipment, which proved entirely successful, was designed for the middle and lower Danube, where heavy seas were liable to be encountered. For the "Pasha" Asiatic Expeditionary Force, a camel transport equipment, composed of light superstructure carried on air-filled rubber floats, proved very successful.

There was no assault bridging equipment, and all such had to be improvised. Its importance was emphasized many times, particularly at the crossing of the Nethe and at the battle of the Marne (1918), besides many other occasions (e.g., La Fére, 1918); and French and Belgian experiences confirmed this. The use of such equipment is often preferable to ferrying, and every Pioneer battalion ought to be equipped with 300 m. of bridge; the rubber float type mentioned above would seem suitable.

The requirements of improvised bridging were well catered for by the tools and material carried in special wagons with bridging trains; but the heavier loads, that have since been introduced, demand more heavy timber, heavier pile-drivers, and mechanically-driven circular saws. Motor transport for all bridging equipment is also clearly indicated; the mechanical maintenance would be a normal task for the personnel of the Pioneer electrical detachments.

Although the pontoon equipment met all requirements during the war, the careful observer cannot ignore the fact that substantial changes were bound to be introduced by the greatly increased weights of modern armament. In considering this, it must not be forgotten that ferrying is much less sensitive to enemy fire than bridging; the crossing of the Marne, in 1918, is a conspicuous example, but for purposes of easy rowing the weight of the pontoon cannot be increased. And lastly, whatever increases in weight of equipment may have become necessary, the available length of bridge, which proved so suitable in the War (35 m. per divisional train, 120 m. per corps train, normal bridge) must not be reduced.

Supply of Technical Stores.

The supply of technical stores, both before and during the War, was directly controlled by the Pioneer Inspectorates, and its smooth working was chiefly due to the fact that experiment, design and provision were all under one head, though the wonderful results that were achieved met with scant recognition at the time. The Engineer Committee, which consisted of three small sections before the War, was employing a staff of over 900 by 1916. General trench-warfare stores were at first all handled by them, but were later taken over by the Ministry of Munitions. This Committee was not unlike the R.E. Board. Anyone could send in inventions or ideas direct to it. It carried out experiments with new devices of every kind and finally settled patterns.

General.

POST-WAR PERIOD.

By the Treaty of Versailles, the Pioneer Corps was limited to seven battalions; *i.e.*, one per infantry division; the battalion to consist of headquarters, two field companies, a bridging column, and a searchlight section. Whether the organization that was mooted in 1918 would have actually been put into force in different circumstances must remain a matter of conjecture. The training of the post-war Pioneer is dealt with in *Der Pionier*, the chief points being summarized in the introduction as follows: the principal feature of Pioneer training is its remarkable many-sidedness. The technical knowledge and skill of officers and men must be such that they may be able to respond to every

* The pontoon was bi-partite, of mild cast steel on a framework of wrought-iron ribs. A cavalry regiment had two 6-horsed wagons, each of which carried two half pontoons, one above the other, and superstructure. call for help, wherever or whatever it may be. This implies full knowledge of the tactics and organization of other arms, thorough infantry training being indispensable. But helping others is only one part, and not the most important of the Pioneer's duties; primarily, it is his business to do technical work that is beyond the powers of others. Modern conditions make it necessary for all arms to do far more for themselves than in the past; but more than enough is left over for the Pioneers.

Training of Other Ranks.

The recruit is trained during his first six months exactly as an infantry soldier. Pioneer battalions inherit the traditions of their forerunners, especially of the storm-battalions, and they must be fully trained in the tactics of assault troops, understanding the construction, working and handling of all close-combat weapons and devices. Physical training, too, is of outstanding importance to the Pioneers. Besides infantry training, the recruit is practised from the start in the use of entrenching and artizans' tools : the clements of bridging, watermanship, and use of explosives also form part of the early training. At the end of the first period, recruits, still in special squads, take their place in a company, where they learn the handling of the machine-gun and various other duties; they complete their training as mates to older soldiers, the whole period amounting to two years. For special branches and employments (e.g., boatmen, wood and metalworkers, electricians), those most advanced in general training, and best suited, are picked out and given special extra training. The greatest possible number are expected to become specialists in some line ; this being particularly necessary for those who aspire to non-commissioned officer rank.

Training of Officers.

The Pioneer officer requires wide knowledge, both tactical and technical; the former so that he may be able to appreciate instinctively the needs of other arms, the latter so as to be in a position to meet those needs. The post-war army makes heavier demands than ever on the Pioneer officer, and very careful selection is, therefore, needed. Aspirants join a Pioneer battalion as volunteers, and do the usual recruit's training, at the same time working methodically for the officer candidate's examination. This examination, which is taken after a school period varying from 11 to 31 years, takes place annually in Berlin, under instructions from the Pioneer Inspectorate. A successful candidate waits three months and then does the first year's course (actually 101 months) at the infantry school. After another examination and a few weeks' interval, which is spent doing duty in the Pioneer battalion, and during which he is gazetted Fahnrich, he goes to the Pioneer school at Münich for about a year. Theoretical and practical scientific courses are given there as well as advanced military training. Yet another examination must then be passed, after which the candidate returns as Oberfahnrich to his unit, where he does duty until his turn arrives for appointment as an officer. The whole training period thus varies from four to six years, depending on the candidate's general educational qualifications.

Duties of the Post-War Pioneer Officer.

It is impossible in a few words to give any idea of the weight and range of the tasks that lie before the Pioneer officer of to-day. The following notes are concerned with some of the more common :---

River crossings assume more and more importance. Practice is equally necessary with equipment and with improvised material; the latter being especially called for by the tendency of loads to go on increasing in weight.

Explosives of all kinds and their use.

Mine warfare in all its aspects.

Field fortification must always have a prominent place.

Camp construction combined with concealment from aircraft.

GERNAN,	per Army, First authorized April, 1915. 7 per Army added by end of year.	I per Army Improvised in 1915, I Electrical Power detachment per Army authorized March, unpany end 1917, I Boring Company formed February, 1918, I Compressed Air Com- luring 1917, Pany formed April, 1918, I Mechanical Pany formed April, 1918, I Mechanical Urring 1918, 1918	1 per Army Nil. Spring, 1915. First in October 2016. Conneelly extended	to all armics. Towards end of 1916.	20,000. 120,000. 770,000.	 1 with E.F. Unofficially formed during 1916 formally approved January 24th, 1917. all Divisions I of 2 per Division on mobilization raised to 1915. I of 2 per Division by middle of 1915. 	vision (with 35 m. normal bridge per Division (in Divisional bridge train). (in Pontoon 120 m. normal bridge per Corps (in Corp. bridge train). m Base Park Special heavy bridge train additional.	e field, from Originally available on scale of roughly 1 per Division. Gradually reduced to 1 per 6 Divisions. No regular scale or allot- ment.	Field Com- At first r section per 2 Divisions. Gradually n disbanded. raised to 1 per Division. 1915. Grad- t unit in the First detachment September, 1915. Grad- ually added to all Divisional S/L, sections.	first regular Improvised winter, 1914, 30 Companies
BRITISH.	Authorized, February, 1915; 1 and at Base.	One formed in September, 1915 ; authorized Autumn, 1916. Boring Section added to each Con of 1916. Airlifts added to each Company d	Improvised beginning of 1915; 1 authorized June, 1917. June, 1915.	Towards end of 1916.	7,000. 14,000. 250,000. 330,000.	Attached before war: mobilized 2 per Division on mobilization : 4 raised to 3 from beginning of 1	. 60 yd. normal bridge per Div Field Companies). 250 yd. normal bridge per Army Parks). Special steel spans of all sorts fron additional.	On scale of 1 per Division in the middle of 1915.	Small detachments attached to panies at end of 1914, but soor Asked for in March, 1915; first field, April, 1916.	Improvised, December, 1914; 1 Company carly 1915.
UNIT.	Engineer Park Companies,	Electrical and Mechanical Companies, etc.	Workshop Companies. Labour Battalions. Teriving Proves at Front	School of Instruction (Officers).	Total peace establishment. Total strength after mobilization. Maximum Excl. transportation. strengt war. Incl.	Divisional Headquarters. Divisional Field Companies.	Bridging Trains, etc.	Army Troops Companies.	Searchlights, {Itand. Searchlights, {Anti-aircraft.	Mining Companies,

Road-making.

Survey has come into some prominence.

Searchlights have produced a whole technique of their own and technicians. Electric power line work becomes steadily more important, as agriculture, industry generally, and railways are electrified.

The foundations of general mechanical engineering are taught at the engineer school, assisted by visits to civil firms.

For employment on fortress construction officers have to specialize.

Conclusion.

The circumstances of the German Engineer and Pioneer Corps have always differed in so many respects from those of the Royal Engineers that exact comparisons have little value. None the less, the general course of development during the war in both Corps had many features in common, which will be apparent from the table appended. The story may be not inaptly concluded with one of the many quotations that embellish Lieut.-Colonel Augustin's pages ; it is attributed to Frederick the Great.

"Think of the future and forget the past.

What is past is done ; it is for the future that one has to prepare."

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THE R.E. CORPS LIBRARIES.

By THE EDITOR.

On the 1st January, 1943, the services of the R.E. Library will cease to be reserved for subscribers, the subscription will cease and the Library will be open to all Members, Honorary Members and Associate Members of the Institution of Royal Engineers. In welcoming the change we might look back into the past and place on record a brief history of the origin and activities of the Corps Libraries.

The earliest of our libraries was founded at Chatham in 1813 and in the following years R.E. libraries were started in many stations both at home and abroad. Their object was explained by General Sir Charles Pasley in his Standing Orders for the R.E. Establishment (Chatham), 1818, in the following words :---" To enable Officers of the Engineers to study their profession in any part of the world to which they may be ordered, without the trouble and expense of moving private libraries, which would exceed the means of any individual." In the course of years the library at Chatham came to be known as the S.M.E. Library and continued to function until the outbreak of the present war, when it was incorporated with the Corps Library which had then arrived at Chatham.

It was not until 1845 that the Corps at large took cognizance of these inde-

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pendent libraries but in that year the Corps Meeting, which was held in the I.G.F.'s office, with the I.G.F., Major-General (afterwards Field Marshal) Sir John Burgoyne in the Chair, appointed a Committee to submit proposals for establishing a central library from which books could be distributed to all parts and to form branch libraries at the headquarters of the various stations. Proposals were submitted and two years later the scheme was finally approved. The Board of Ordnance, under whom the Corps were then serving, expressed their approval and agreed to bear the cost of postage and shelving—privileges which were continued by the War Office when the Board was abolished and which are still a valued concession to the Corps.

To form some idea of the magnitude of the scheme, by the year 1862, when the first catalogue was published, the central library in London was providing for thirty-five branches, sixteen at home and nineteen abroad. Some of the latter, Bahamas, British Colombia, Montreal, Corfu, New Zealand, St. Helena, Van Dieman's Land and Western Australia, give some evidence of the activities of the Corps in those days. In this connection the following observation circulated by the original committee in 1845 shows how far the Corps had gone even then since Pasley's day:---" That officers of the Engineers are now employed, independently of their professional duties, by the Government in various and important duties, bringing them into contact with the heads of public departments and with professional people, making it essential that they should be acquainted with the important improvements of the day," and for this they require access to works of reference " too bulky and too expensive to form part of an officer's private library."

Records of the following years tell of new branches started and others being broken up, with their books distributed to other branches. In 1871 the New Zealand books were lost at sea on their way to the Straits Settlements. Libraries in India were not included in the scheme and officers stationed there are excluded from the benefits of the Corps Libraries.

Up to 1871 the central Library was housed in the I.G.F.'s office in Pall Mall and in that year it moved with him to the Horse Guards, but it was not until 1906, when the War Office staff went over to the new War Office building, that the Library obtained possession of the spacious room over the Horse Guards arch, of which it retained precarious possession until the outbreak of the present war. Then the Library had to pack up and clear out in a hurry. The Library came to Brompton Barracks and the War Office, mindful of their old-time promise, gave it generous shelving in the quarters adjoining the headquarters mess.

That the move was successfully accomplished was due to the zeal and initiative of the librarian, Mr. F. C. Johnston, now serving with the Forces. To him and to the present librarian, Mr. A. R. Brown, we owe it that some 13,000 books were packed, transported and finally rearranged in their several groups with a minimum of inconvenience to the subscribers. Two former librarians deserve mention in this brief record, Mr. S. G. Thornton, who served the Library for 54 years until his retirement in 1923, and Mr. J. G. Scott who succeeded him and died in harness in 1935. Mr. Scott's work in compiling the catalogue published in 1929 deserves a special mention.

At present the activities of the Library are at their lowest ebb. No demands for books come from the few branch libraries that still exist; the Aldershot branch languishes and an offer to start a branch at Ripon remains in abeyance. Individual officers still write for books, but the demand is not great and no new books are purchased unless they are asked for.

Of course the war is to blame for this state of affairs, but after the war the demand for special books in which officers can study the many subjects dealt with in the various branches of their profession will undoubtedly increase. The Library contains no light literature, but its aim is to keep up to date in books on the Art of War, Civil Engineering and History, Travel, Biographies and works of Science and Art generally, and books not in the Library can often be obtained through the National Central Library. From the 1st January all Members, serving in the British Isles, can take out books and on their return the cost of postage is refunded.

As a reading room the Library is open on week-days to all Members stationed in the neighbourhood, and many British and foreign publications and journals which are received from various learned societies in exchange for Institution publications are placed there.

Altogether, the benefits gained for Members by this new arrangement will be considerable.

CORRESPONDENCE.

THE ROYAL ENGINEERS AND THE ROYAL TANK CORPS.

To the Editor, The Royal Engineers' Journal.

DEAR SIR,

This will supplement the article in your September issue on "The Royal Engineers and the Royal Tank Corps during the war of 1914-1918."

During the last war I was the Secretary of the Railway Executive Committee and remember one day being rung up by Capt. Mance (now Brigadier-General Sir Osborne Mance), who at that time was in the Directorate of Movements : he asked me how many wagons the Railways possessed which were capable of being loaded with a tank about 15 ft. long by 8 ft. 6 ins. wide by about 6 ft. high and weighing some 15 or 18 tons. I told him not to be funny, that a tank of those dimensions would not weigh more than about 3 tons, and he replied "Well 1 for the purposes of the joke, let us call them tanks."

A programme for building additional wagons had to be embarked upon, the Government financed it and the Railway Executive Committee undertook the design and construction.

It is the practice of the Railways to christen special types of wagon with a code name, e.g., Crocodile, Macaw, etc. ; I thought to christen the new speciallydesigned wagons "Tankard" but feared it might be confused with tank wagons (for liquids) and—as the R.E.C. were fathering the wagons—I suggested they be called "RECTANKS," and one can see many of them running about to-day, their numbers having increased of recent years.

> Yours faithfully, Gilbert S. Szlumper, Colonel.



Brig - Gen E G Godfrey-Faussett CB CMG

MEMOIRS.

BRIGADIER-GENERAL E. G. GODFREY-FAUSSETT, C.B., C.M.G.

BRIGADIER-GENERAL E. G. GODFREY-FAUSSETT died on 29th May, 1942, at his home at Hadlow Down, Sussex, at the age of 73. "G.F.", as he was universally known, was educated at Winchester College, whence he went to the "Shop" passing out top of his batch and senior Under Officer, to a commission in the Corps in February, 1888. From his first unit, the Field Depot, R.E. Troops, at Aldershot, he transferred to the 1st Divisional Telegraph Battalion, and so began his long and distinguished connection with Signals, to whom he remained faithful practically throughout his service. After a tour of duty in St. Lucia he came back to the 2nd Divisional Telegraph Battalion in 1897, in which year he married Mabel, the daughter of Sir Augustus Hemming, G.C.M.G. His promotion to Captain in 1898 was soon followed by his departure to the South African war. Owing to a casualty on the journey out he found himself Chief Telegraph Officer, and remained so for some considerable time during the campaign. This was a great chance and responsibility for so junior an officer, and he rose to the occasion with great success, establishing excellent relations with "Bobs" and " K " and the Staff, with consequent benefit to the Signal Service and to the Army. He got his Brevet Majority in 1900 and was twice mentioned in despatches.

After the war he returned to the 2nd Divisional Telegraph Battalion at Aldershot, was promoted Major in 1906, and did a tour of duty in London as Secretary to the R.E. Committee, and with the Director of Fortifications and Works in the War Office. In 1910 he returned to Aldershot in command of "A" Signal Company, the formation of which unit ushered in the first big re-organization and expansion of the Signal Service, which had been under contemplation for some time. Four years of growing Signal activity followed, and those who served with "G.F." in those days will have many happy recollections of the annual Signal camps, at which all Signal Units congregated for a month's collective training, and of Army manœuvres under his leadership. They will remember him as a Commander who inspired affection, loyalty and enthusiasm in his Officers, N.C.Os. and men, and who possessed the great attribute that while being master of every detail of his job, he would decentralize and trust his subordinates and stand by them in cases of trouble.

1914 saw him in France in the first week of war as O.C., G.H.Q. Signals, and during the retreat from Mons his unflagging energy and never-failing cheerfulness were an inspiration to all who worked with him. When the First Army was formed he became its Deputy Director of Army Signals, which appointment he held until the Fifth Army came into being in 1917, when he was transferred thereto, and so to him fell the tremendous task of organizing Signals during the retreat of 1918. He was created C.M.G. in 1915, C.B. in 1919, obtained his Brevet Colonelcy, and was six times mentioned in despatches.

After the war he became Commandant of the Signal Service Training Centre at Bedford, and in 1920 carried out its move to Maresfield Park in Sussex. There he stayed until his retirement in 1922, and during that period saw the birth of the Royal Corps of Signals. As the responsibilities and technical requirements of Signals had expanded during the war, "G.F." had visualized and preached the necessity for the formation of a separate Corps, and the new Corps owed much to him for the spade work he did and for the proper laying of its foundations. It was with well justified satisfaction that he saw his vision become a reality in 1920.

He retired on the 6th May, 1922 in the rank of Brigadier-General and settled in his charming house and garden, "Annes," at Hadlow Down, not far from the scenes of his last command. Retirement for "G.F." did not mean a lapse into inactivity; he and his wife were soon very busily involved in many local and public activities, in addition to which "G.F." expanded the interest he had always had in the Boy Scout movement, and was soon one of its leading administrators. Starting as Assistant District Commissioner for No. 3 District of Sussex, he became the Imperial Headquarters Commissioner for the training of Scouters, in which capacity he contributed much to the building up of the Scout training system. In 1938 he became County Commissioner for Sussex, while from 1928 until his death he was a member of the Council of the Boy Scouts Association.

He led the Rover Contingent at the Kandersteg Moot of 1931, and the British Scouts at the International Jamboree in Hungary in 1933; but perhaps one of his greatest achievements of organization, and "G.F." was an organizer par excellence, was as Camp Chief of the coming-of-age International Jamboree at Birkenhead in 1929. Here he controlled every detail of organization and a host of subordinates, none of whom were paid for their duties. In spite of the vilest weather and the difficulty of looking after 30,000 Scouts from almost every country in the world, the Jamboree went from start to finish without a hitch. His many friends can conjure up a picture of his stocky figure on a still stockier pony making his daily morning round of every corner of the camp, through seas of mud, inspiring everybody and removing the "im" from impossible.

His son Peter resigned from the Ceylon Forestry Service in 1940, and came home to join the Army. He was commissioned in the Rifle Brigade and now holds the rank of Major. His daughter Joyce is married to Major E. L. W. Cumming, R.A.O.C., and is at work in this country.

In the intervals between "scouting" and other public work, "G.F." put his still abounding energy into his garden. His study was characteristic; a small room, for "Annes" was not palatial, lined with shelves and drawers, and crowded with books, plans and statistics. He was always happiest when hard at work, and it was while at work in his beloved garden that he died.

G.G.R.

BRIGADIER-GENERAL E. M. P. STEWART OF COLL, C.B., C.B.E.

ERNEST MONCRIEFF PAUL was the only son of Mr. Henry M. Paul, of Glasgow, who emigrated to Australia in the '60s, where the subject of this memoir was born at Sydney, on 2nd September, 1864. A few years later, Mr. Paul returned to this country, where he became Manager of the New Zealand Loan and Mercantile Agency in London. His son was educated at King's College School, London, and at Marlborough College, from which he joined the Royal Indian Engineering College at Cooper's Hill. In 1885 and 1886 a number of commissions in the Royal Engineers were offered to cadets from Cooper's Hill and Paul was commissioned as Lieutenant, R.E., on 6th January, 1886. After two years at the S.M.E., he elected for Indian Service and in 1886 joined the Military Works at Barrackpore, becoming Executive Engincer at Allahabad in 1891 and at Rangoon in 1892. In 1893 he was selected for the appointment of Assistant Instructor in the Construction School at the S.M.E., but before leaving India he married, at Simla, Katherine Harriette, daughter of Mr. William Coldstream, of the Indian Civil Service.

On completion of five years at the S.M.E. Paul became Division Officer at Harwich, where new defence works were under construction, and in 1900 he was ordered to Gibraltar to command the 49th Company, R.E.; he was promoted Major on 21st December, 1903. In 1904 he was ordered home to take up the appointment of Instructor in Estimating and Construction at the S.M.E., which he held until 1908. During this time, in addition to the work of his appointment, which involved the revision of many technical pamphlets, he qualified as an Interpreter in Russian. In 1908 he became Major of the Training Battalion, and commanded



Brig - Gen E M P Stewart of Coll CB CBE

the Battalion for a time in 1910. At the end of the year he was appointed C.R.E. Colchester, which carried the dormant appointment of C.R.E. 4th Division of the British Expeditionary Force, which was then being formed ; he was promoted Licut.-Colonel on 1st October, 1911. The following year he was ordered abroad as C.R.E. Ceylon, where he was stationed on the outbreak of the last war. The work in Ceylon for the first six months of the war was much the same as at other Eastern stations, first the putting into force of the Defence scheme for the defended coaling station of Colombo and then a period of waiting for the war at sea to develop, but when the German fleet in eastern waters had escaped across the Pacific to meet its fate at the Falkland Islands and the German raider Emden had been destroyed, the Eastern garrisons were gradually weeded of regular officers and men. Paul's turn came in March, 1915, when the Expedition under General Sir Ian Hamilton was despatched to occupy the Dardanelles in support of our Fleets. This expedition was organized in the same way as the original Expeditionary Force for France, with a Colonel of Engineers as Adviser at G.H.Q. and another Colonel as Director of Works to carry out any Engineer work required under the directions of the Q.M.G. Staff of the Army. Paul was appointed Deputy Director of Works with the local rank of Colonel and ordered to join at Alexandria, which was the first base of the Force. He thus began a period of intense and important Engineer work in the Eastern Mediterranean which lasted for over four years, during which he visited many places and served many masters. Partly owing to his early training at Cooper's Hill and partly to his employment at the S.M.E., Paul had become a highly qualified constructional engineer, which, combined with a matter-of-fact outlook, great industry and plenty of tact, specially fitted him for the work he had to do. His training as an Engineer had taught him the necessity of foresight, the taking of a firm grip of the problems confronting the Engineers and the early provision of the stores and appliances, without which the best Engineer cannot produce good work. The first R.E. Officer appointed as Engineer adviser of the force was Colonel A. W. Roper and the first Director of Works was Colonel G. S. McD. Elliott.

On a review of the situation, it was evident that little help in the way of materials would be available in the area it was proposed to attack and that even water would have to be supplied by sea. Alexandria was therefore organized as a base, where supplies could be accumulated ; these came partly by ship from this country but there was also a supply which came into Egypt from the East and which had to be distributed to the garrison and inhabitants as well as to the force at the Dardanelles. This distribution was effected by a Resources Board which sat at Cairo.

Stores could only be landed on the beaches at Gallipoli from lighters or small vessels and one of Paul's first acts was to charter on his own authority three small vessels, so that Engineer stores could be sent direct from Alexandria. These vessels had a long and useful career and this trespass on Naval preserves was condoned by the Commission of Enquiry which investigated the transportation services of the campaign. The principal Engineering problems at first were the water supply, the construction of piers at the beaches when these were occupied and the construction of cover in the trenches, but the supply of stores, especially timber, was always short.

At first the Director of Works and his staff were at Helles but the arrival of German submarines in the area made it necessary to establish General Headquarters on the island of Lemnos, which had been used for some months as a Naval base and where the fine harbour of Mudros had been made into a safe refuge for all forms of sea transport. This brought its own problems, as piers had to be constructed and accommodation provided. Among others, hutted hospitals were constructed on the island in anticipation of a winter campaign and by October, 1915, a general hospital of 1,024 beds and two others of 624 were ready.

Meanwhile the increase in the size of the Army had caused the formation of

Corps and among the extra troops was a strong force from India; the senior R.E. Officer with this force was Colonel Godfrey Williams, who was considerably senior to Roper. Williams was therefore appointed Engineer-in-Chief of the enlarged force. About the same time Elliott went home and Colonel A. G. Joly de Lotbinière, also from India, was made Director of Works in his place.

By this time demands had been sent home for a supply of water stores, pumps of all kinds, piping and tanks, and when the additional force was sent out for the Suvla landing it was accompanied by a whole shipload of water supply stores, but by one of those strokes of bad luck of which there were so many in this campaign, these stores were not landed on arrival and a day or two later the ship with its precious freight was sunk.

Paul was promoted Colonel on 1st November, 1915, and on 23rd November was appointed Director of Works, an appointment which he retained until June, 1919; he was given the rank of Brigadier-General. He thus became responsible for the Engineer services during the evacuation from Suvla and Anzac.

By February, 1916, the headquarters of the Force at Gallipoli had withdrawn to Egypt. The military position in that country was somewhat peculiar, the G.O.C. of the garrison of Egypt and the Sudan was General Sir J. Maxwell, who was responsible for the defence of Egypt, but located in his command was the headquarters of the "Mediterranean Forces and Levant base" under General Sir Archibald Murray, who was responsible for the Canal defences and all operations in the Eastern Desert and also for all detached forces in the Eastern Mediterranean, including Cyprus and Salonika, where a British force was growing in strength. Paul was Director of Works with the Mediterranean Force with Major-General G. Williams as his Engineer Chief, of whom he had a very high opinion and with whom he worked in complete accord.

But with the best will in the world this double organization proved unworkable and in April, Maxwell was brought home and Murray became the C.-in-C. of the whole force. Williams had been ordered back to India to become Director of Military Works in that country and Colonel H. B. H. Wright, who had been Chief Engineer in Egypt under Maxwell, was made Engineer-in-Chief of the combined force; Paul was not placed directly under his orders but reported to the Inspector-General of Communications. His responsibilities now covered the Engineer Services for Egypt, the Western Desert front and the Canal defences, Salonika and Cyprus. This latter island was not only a source of timber but was the location of camps for Prisoners of War. All work on aerodromes and depots of the Royal Flying Corps was still the responsibility of the Royal Engineers and this included the base of the Royal Naval Air Service at Mudros.

In August, 1916, Paul visited Salonika at the request of General Sir G. F. Milne, to report on the organization of Engineer services in that theatre of war, and Milne accepted all his recommendations. In November, 1916, the post of Inspector-General of Communications in Egypt was abolished and all the Directors were placed under G.H.Q., Paul reporting to the Deputy Quartermaster General. At the same time the Engineer work was divided between the two senior Engineer Officers; the Engineer-in-Chief was made responsible for the Western Desert and the Eastern Forces, while the Director of Works was in charge of all services in the Delta and Alexandria districts, and was responsible for the provision of stores, including those for Salonika. This arrangement did not prove altogether satisfactory and the Director of Works was gradually called on for more and more work in the fighting areas.

During Murray's campaigns in the Eastern Desert in 1916 and 1917 which included the two battles of Gaza, the advance of the Army depended very largely on two Engineer problems, the extension of the railways and the water supply. The railway work was undertaken by the R.E. Officers on the Egyptian State Railway, but the water supply was dealt with by the E.-in-C. and Director of Works. In many places in the desert there were small springs, forming oases, which had to be developed by the R.E. on the spot, but these were not nearly sufficient to provide for the whole Force. A scheme was therefore prepared to supply water from the Fresh Water Canal in Egypt, which runs on the west side of the Suez Canal, to a point west of Gaza, a distance of 87 miles. The scheme involved the erection of four complete pumping stations, each with reservoirs, connected by several lines of 10-12 inch piping, the water being siphoned under the Suez Canal. Paul worked out the details, and these were received in the War Office in July, 1916. Orders were placed in the United States, the stores required were shipped out direct in charge of an experienced American Engineer and the work was completed in February, 1917. At the beginning of 1917 Paul initiated a system of salvage for the recovery of Engineer stores.

In June, 1917, General Sir Edmund Allenby was appointed C.-in-C. in place of Sir Archibald Murray and on arrival asked that his headquarters should be moved further east, that Base depots should be formed at Kantara, that more hospitals should be provided and that there should be additional aerodromes and accommodation for a 100% increase in the Royal Flying Corps. Wright had gone on leave on the 6th July and Paul was acting Engineer-in-Chief. He told Allenby he would have a hutment camp for a small advanced Headquarters ready at Khelab, 207km. north-east of Kantara, by the 12th August, have it enlarged by the 1st September and complete for the whole of G.H.Q. on the 1st October ; and noting the coincidence of dates' added that he would supply suitable game—grouse, partridge and pheasant—as conveniently as could be after those dates ! Allenby asked if Paul was a man of his word and, on being told he was, accepted the programme. Wright returned in time for operations in the winter of 1917, which resulted in the occupation of Jerusalem.

In July, 1918, Paul as Director of Works took over the Engineer work on the Palestine Lines of Communications, and at the end of the month, Wright went on leave, and Paul was again acting in the double capacity, becoming.responsible for all the Engineer preparations for the decisive battle which began on 19th September, 1918. Wright would have been back, but Allenby, to forestall the Turks, advanced the date of his attack by a fortnight, so that Paul was acting Engineer-in-Chief during this critical stage. The principal new Engineer work was the provision of prisoners of war camps; accommodation was provided for an estimate of 60,000 prisoners, in fact there were 98,840.

Paul remained in Egypt after the collapse of the Turks until June, 1919, during which time he had to break up the war organization he had built up and also to carry on the duties of Chief Engineer in Egypt, including the Engineer services for the Royal Air Force, which, though it had been made an independent Arm of the service in April, 1918, still looked to the R.E. for its Engineer services.

From July, 1916 to January, 1919, the Director of Works sent a monthly semi-official report to Major-General Scott-Moncrieff at the War Office. These letters, which were prepared by Paul, numbered 36 and were illustrated by upwards of 600 photographs, which form as complete a documentation of their subject as is available for the last war. They are known in the Historical section, with the approval of their author, as the "Pauline Epistles" and show Paul's grasp of his duties in regard to hutted camps, water supply, aerodromes and the provision of Engineer stores. His broad outlook is a model for any Engineer Officer in a similar appointment and it is to be hoped that an opportunity may occur for the publication of extracts from these letters.

On arrival home Paul was appointed Deputy Director of Fortifications and Works at the War Office from the 3rd September, 1919, where he remained until his retirement under the age rule in September, 1921. On the 15th January, 1920, the D.F.W., Major-General Sir Philip Twining, died after a short illness and his successor, Major-General Sir William Liddell, was not appointed until 6th April, 1920. During this interval Paul carried on the work of the office to the complete satisfaction of the Master-General of the Ordnance, Major-General Sir J. P. Ducane. Among other work he found time to visit Ireland, where the writer was struggling with the Engineer work for a largely increased garrison with less than the ordinary peace establishment of Engineers and on our urgent representations Paul was able to obtain much wanted assistance.

On retirement he settled in a flat in Kensington, occupying his time with various interests. During his service he had lost no opportunity of visiting other countries, and had travelled in Central Asia, Russia and North Africa, combining his journeying with confidential work for the Intelligence branch of the War Office. He was a Fellow of the Royal Geographical Society. He took great interest in the Palestine Exploration Fund, of which he was for a time the Honorary Treasurer, and was also a member of the Executive Committee and a Trustee. He was also a Trustee of the Royal Soldiers' Daughters' Home at Hampstead, Vice-Chairman of Miss Sheppard's Annuitants' Homes, a life Governor of Marlborough College and of the London Orphan School, Watford. He was also an interested member of the Royal Central Asian and Indian Empire Societies and Chairman of British Trusts and Securities Corporation. In the course of his military work he wrote many reports on military subjects and published a book on *Road Construction and Maintenance*.

In 1932 he inherited by deed of entail the ownership of the Island of Coll, off the west coast of Argyllshire, succeeding his cousin, Mr. Charles E. Stewart, and assumed the name of Stewart of Coll. The island is small and windswept but Paul took his new duties seriously, going into residence in Breachacha Castle on the island and doing everything he could to forward the well-being of the inhabitants. He was made a J.P. for the county of Argyllshire.

He was very proud of his large family of five sons and one daughter, all of whom took good positions in life. His daughter, now a widow, married Mr. Bruce L. Cameron, of the Indian Public Works Department. His eldest son, now Stewart of Coll, was Lieut.-Colonel H. W. M. Paul, O.B.E., M.C., lately commanding the 1st Battalion Middlesex Regiment in Hong Kong and now a prisoner of war in that island; his second son, Captain G. A. M. Paul, R.N., is employed at the Admiralty; his third son, and Lieutenant E. K. M. Paul, M.C., R.G.A., died of wounds at Ypres in 1918; his fourth son, C. S. T. Paul, is a Civil Engineer in London; his fifth son, J. S. M. Paul, joined the Sudan Government Service, and was accidentally electrocuted in 1932 when going to the assistance of a native who was clearing trees which had made contact with an electric main.

On the outbreak of the present war Paul remained in Coll and on the formation of the Home Guard was made a Lieutenant in the force. The population of the island was less than one hundred in number and was slowly decreasing as the younger members were drawn away to the mainland. Shortage of labour and rising prices made it increasingly difficult to maintain his position in the island, and at the end of 1941 he decided to close the castle on Coll and return to his London flat. He was not in good health and after some attacks of bronchitis he passed away on 11th April, 1942, in his 78th year.

For his services at the Dardanelles and in Egypt he was four times mentioned in Despatches, was given the C.B. in 1915 and the C.B.E. in 1919; he was also an Officer of the Order of the Nile.

The writer is indebted to Lieut.-Colonel J. S. Yule, late R.E., and a member of the Historical section, for the information about the Pauline Epistles and for the extracts from them which are embodied in the above, and this memoir may aptly close with Yule's final words, "Paul's work in Egypt was a fitting climax to the preparations of a lifetime. To the young Officer who heard his lectures at Chatham there appeared the balance between the soldier and the engineer, and if Paul himself inclined to the engineering side, it was always to study how civil engineering could serve the needs of an army in the field. What he advanced in theory at Chatham he put into practice in Egypt. . . . He was no respecter of persons; he talked to Lord Milne and Lord Allenby as man to man. He was trusted."



Brig - Gen Geoffrey D Close CB

MEMOIRS.

BRIGADIER-GENERAL G. D. CLOSE, C.B.

GEOFFREY DOMINIC CLOSE, the second of five brothers, sons of Major-General Frederick Close, Royal Artillery, who obtained commissions in the Corps, was born on the 8th July, 1866, and was commissioned from the Royal Military Academy on 29th April, 1885. On leaving the S.M.E. in 1887 he joined the Expeditionary Force in Burmah, but a severe attack of dysentery soon brought him home on sick leave and in 1888 he was back at Chatham, the possessor of a medal and two clasps. In 1890 he returned to India and the Q.O. Madras Sappers and Miners at Bangalore, from whence he was sent on Telegraph duty to Umballa and earned another clasp to his medal for service in the Hazara Expedition of 1891. In 1892 he returned to Chatham and served there until 1896, when he went to Malta for a five-year tour. In 1901 he was posted to the Curragh and in 1904 went to Port Royal, Jamaica, for two years. In 1906 be was D.O. at York and from 1909 to 1912 he served in Hong Kong. Promoted Lieut.-Colonel in August, 1910, in 1912 he became C.R.E., Exeter. His promotion to Colonel was dated 16th December, 1913. In the European War, he served in Gallipoli as C.R.E. of a division with the Central Force ; he was wounded and returned home and on recovery was appointed Chief Engineer with the Northern Army, Home Forces, and later, Chief Engineer, XXIII Corps, Home Forces, with the rank of Brigadier-General. For his services in the War he received the C.B. in 1918. In 1920 he became Chief Engineer, Northern Command at York, and he retired from the service in December, 1921. As a legacy of the Burmah illness his health was never very good, He died at Cheltenham on the 1st June, 1942, after a long and distressing illness.

A brother officer writes :-- " I think it might truly be said that he had a host of friends and no enemies. A man of very even temperament and sometimes very amusing and witty. He did his work, whatever he had to do, with a minimum of fuss and bother, and was always able to help others in time of difficulty. He was fond of golf and was a good average player and a good bridge player."

LIEUTENANT-COLONEL E. V. BINNEY, D.S.O.

LIEUT.-COLONEL EDWARD VICTOR BINNEY was in command of an O.C.T.U. when he was killed in a road accident at Aldershot on June 14th, 1942. He was the son of Mr. T. G. Binney and grandson of Mr. E. W. Binney, F.R.S., a distinguished geologist who had a great deal to do with the discovery of oil from shale. His mother was Susan Lockhart Hobson, the eldest daughter of the Rev. W. Hobson, the Rector of Douglas, Isle of Man. In 1884 his parents took a voyage to Australia in a sailing ship for the benefit of his father's health and Victor was born at Melbourne on March 4th, 1885, the second of six brothers.

As a boy he was much above the average intellectually. In 1896 he joined his elder brother, who is now Admiral Sir T. H. Binney, K.C.B., D.S.O., at a preparatory school, Cordwalles, at Maidenhead and in his second term went into the sixth form. He went on to Rugby, where he gained the best modern scholarship of the year and was in the sixth form while he was still 15. In 1901, he passed into the Royal Military Academy, Woolwich, and became an Under Officer; he passed out first with the Pollock Medal.

He was commissioned in the Royal Engineers on 25th July, 1903. He did extremely well at the S.M.E. and gained the Haynes Medal for Field Works and the Montgomery Prize. On leaving the S.M.E. in December, 1905, he was posted to India. His first two years in India were spent in the Works Service, his last station being Dera Ismail Khan, which included Wana. In 1908 he joined the Bombay Sappers and Miners and was posted to the 17th Field Company. His Commanding Officer at that time recalls him as having been a charming boy with an unruly head of hair.

At this time, the officers in the Bombay Sappers and Miners played games as hard as they worked and this might have been a handicap to Binney, who was not brilliant at games. By hard work, however, he achieved a place in the Regimental Polo and other teams and took an active part on the river. He quickly made a place for himself in the Corps and was able, in his unobtrusive but efficient way, to act as elder brother to the new arrivals. In 1910, the 17th Field Company was sent to Quetta and was probably the most efficient company in the Bombay Sappers and Miners, much of the credit for which was due to Binney.

In 1913, the Commandant, Colonel U. W. Evans (now Brig.-General U. W. Evans, C.B., C.M.G.) offered Binney the appointment of Adjutant at Kirkee. Adjutancy of a Corps of Sappers and Miners was not a very popular post, since it offered few chances of active service, so he accepted a trifle reluctantly. His dread of losing a chance of active service was realized to a certain extent in 1914. as he could not be spared from his post. The Commandant was detailed as C.R.E. 6th Poona Division for service in Mesopotamia, and so the bulk of the work of mobilization fell to the Adjutant. There was no precedent for a sudden mobilization and the Adjutant had to do everything single-handed for at least six months, as there were no regular British officers available, nor did A.I.R.O. officers arrive and become trained until later. No one will ever know the full debt of the Bombay Sappers and Miners to Victor Binney during the first two years of the war. He shouldered alone the burden now shared by several officers in more than one Battalion. The work was thoroughly well done and during the two years 1914-1916, when the strength of the Corps rose from 1,500 to the neighbourhood of 12,000, he worked like a Trojan, longing to get away on active service, seeing newly-fledged officers going overseas in large numbers, and nobody arriving to replace him. He was always calm and unruffled, accessible and courteous to all. The following, from an officer who joined the Corps in July, 1914, shows how Victor Binney was able to carry an immense load of work and responsibility and yet have time to help others in the best possible way to learn and carry out their duties.

"He was Adjutant at Kirkee when I joined the Corps in July, 1914. My Company Commander immediately went on leave and I found myself mobilizing the 20th Company as a very raw recruit. Victor was marvellous, he never interfered with me but at the same time his experience and grasp of detail was immense and he knew where to find the solution to every problem."

In 1916 his chance came. The Field Companies in the Division were increased from two to three and he was given command of the 18th Field Company, which he mobilized and took to Mesopotamia. This was a difficult task because the 18th Field Company had been split up entirely and used for reinforcements several times since the beginning of the war.

He did wonderful work at the Base at Basra during the tail end of the hot weather and this enabled him to get the Company together before the Autumn, when he took it up to join the 20th and 21st Field Companies of the Bombay Sappers and Miners in the 3rd Lahore Division. They were soon engaged in the bitter fighting leading to the recapture of Kut and the taking of Baghdad.

A brother Sapper and Miner officer in the 3rd Lahore Division writes of Binney at this time :---

"He was exceptionally cool-headed in action, verging on being foolhardy in danger. At any rate he was apt to wander about no man's land in front



Lieut-Col Edward Victor Binney DSO.

of Kut without an orderly, walking in the dark from his own brigade front to ours without apparent concern for friend or foe."

He took a leading part in operations in the Khairdari Bend, December, 1916-January, 1917, an account of which, written by him, was published in *The R.E. Journal* in September, 1937. With his characteristic modesty he does not mention himself in the action at all but during the operations he was wounded twice, the first a slight wound, and he earned the D.S.O. The second wound was more serious and led to his being returned to India.

On recovering, he joined again at Kirkee as Superintendent of Park. At this time there were very few experienced officers available and it was clear that the whole well-being of the Corps centred in his knowledge and influence but he never allowed anyone to think he was going outside the confines of his own job. He was very modest and had a delightful way of making much of his own difficulties and so letting others think they knew as much as he did, which was encouraging to those who recognized how beyond them in ability he was. It was this trait in his character which enabled him to exert so great an influence and give so much help to others in such an unobtrusive way.

He was in command of a Company of Bombay Sappers and Miners in the third Afghan War in 1919 and then was sent to Palestine, where he commanded the 76th Field Company, Bombay S. and M. and for a time was C.R.E. of the 3rd Division, E.E.F.

He went home on leave from Palestine in 1922 and rejoined from leave at Kirkee. On the passage out to India he met Marjorie Blanche Brook-Mockett, daughter of Mr. and Mrs. Brook-Mockett, of Prescot House, Ealing, to whom he became engaged to be married shortly after reaching India, and whom he married in Madras in 1923.

On rejoining at Kirkee he was put in command of the 17th Field Company. In 1924, he was appointed Superintendent of Park. The Superintendent of Park was in charge of the trades training of the Corps and under Binney's direction, a steady programme of development of workshop facilities was put in hand and the standard of trades training improved. His two children were born at Kirkee during this period; a daughter. Anne, on 7th March, 1924 and a son, Giles, on 21st January, 1926.

He reverted to the Home Establishment in 1928 and served for a time as D.C.R.E., Hipswell. On 1st January, 1929, he was promoted Lieut.-Coloneland on 4th May was appointed Commandant of the Royal Bombay Sappers and Miners. (The Royal title had been granted in recognition of the fine work carried out by the units of the Corps during the War.)

Most of his service had been spent in the Royal Bombay Sappers and Miners and he was devoted to the Corps. He was an ideal Commandant. His interest was in everything for the good of the Corps ; training for war, sport and the welfare of all ranks. He was always approachable, always ready to listen and always pleasant to others but his authority was unquestioned and what he said was law. Under his command the reputation of the Corps for all-round efficiency reached fresh heights. He had great love for and understanding of the Indian ranks and they undoubtedly loved him. In his case, the expression man bap was no empty phrase. The joy with which he was received by all the old soldiers at the Reunion which he organized in 1932 spoke for itself. His interest in the welfare of the Indian ranks gave him the idea of providing a Welfare Centre for their families. This consisted of a dispensary, waiting-room, consulting room and two lying-in wards, and was built by Sapper labour. An Indian woman doctor was put in charge. In view of caste prejudice and customs concerning women, this was a bold step forward in social welfare, in which he was enthusiastically supported by the Indian officers. His three years tenure of command came to an end on 11th July, 1933. He and Mrs. Binney were given a wonderful send-off from Kirkee and it seemed that his Army service was ended, as he retired on his pension to a life of comparative inaction which was not satisfactory to one of his abilities.

In June, 1934, however, he was offered and accepted the appointment of Secretary to the Institution of Royal Engineers. All who worked with him or for whom he worked in this capacity, speak with enthusiasm about his work. He was responsible for making The R.E. Journal what it became, a really valuable professional publication. He was always looking ahead for material, encouraging men to write and had sound judgment on the value of the articles submitted. His reputation in India and his many friends, helped him to know whom to approach for an article on any particular subject, because he knew who were qualified to write on it. He took a keen interest in the Library and did much to improve its cataloguing system and clear it of out-of-date books. He was largely instrumental in carrying through the preliminary negotiations and the movement of the Library to Chatham. He was also a prime mover in the preparation of a new volume of Corps History, for which he wrote some valuable articles himself. The outbreak of war has put a temporary stop to this work and the volume is still in draft as he left it when he was called away on mobilization, to command the Officer Cadet Training Unit which was formed at Aldershot, during September, 1939, and which he was commanding at the time of his death.

He was very well suited by character and experience for such an appointment. An Officer who served under him at the O.C.T.U. for most of the time he was in command, writes :--

"Under his leadership the difficulties normally associated with the formation of a new unit were overcome and before long a steady stream of young officers was being produced. Binney made a point of getting to know every individual cadet. He had a remarkable gift for remembering the names, faces and characteristics of the cadets and followed closely the details of their training throughout the Course. When interviewing cadets whose progress was not considered satisfactory, he was always willing to give them a chance to make good. His wisdom and justice in administering discipline was appreciated by all under his command. He never had as a nickname 'The Old Man' but was often referred to as 'The Old Gentleman.'"

The writer of this memoir has received a large number of letters from officers who served, either with Binney or under his command, and from senior officers who met him and worked with him after his retirement. All letters show a remarkable unanimity in their estimate of him as a man of outstanding mental abilities, strong character, inspiring personality and capacity for work and, moreover, a man with whom it was a pleasure to work. He was fitted to fill very high rank in the army. From the point of view of advancement, the war of 1914-18 came at an unlucky time for him. He intended to sit for the Staff College when he had completed his time as Adjutant but the war intervened. After the war he was too old to sit for the examination and his comparatively short period of active service and the fact that he had no brevet rank, probably led to his not receiving a nomination. He was not the one to advertise or press his own claims. He was satisfied to do superlatively good work and let it speak for itself. He lived the life of a regimental officer, entirely bound up in his Corps and so denied himself the opportunity of personal advancement.

The words of a brother officer in the Royal Bombay Sappers and Miners, are a fitting epitaph.

"He remained one of the band of regimental officers whose labour, though not apparent to the outside world at the time, fructifies in the work and deeds of those whom they train and continues to seed and flower long after they have passed on, among generations of soldiers who may never have heard their names."

J.S.W.S.

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All Reviews of Books on military subjects are included in the provisions of K.R. 547(c) 1940.

BOOKS.

(Most of the books reviewed may be seen in the R.E. Corps Library at Brompton Barracks, Chatham.)

THE OFFICIAL HISTORY OF AUSTRALIA IN THE WAR OF 1914-18. Vol. VI. The A.I.F. IN FRANCE DURING THE ALLIED OFFENSIVE 1918. By C. E. W. BEAN.

(Angus & Robertson, Ltd., Sydney) (1096 + Ixxvi pp. with 530 illustrations and maps.) This volume, which we have received from the Australian War Memorial, Canberra, completes the Australian Official History of the War of 1914-1918 and embraces the period from May, 1918, to the Armistice. In the Preface the author explains how his work was affected by the dates of publication of the British Official History and says that the present volume traverses ground which is largely virgin, at least for official history. Chapter XIV Der Schwarze Tag, describing the Australian attack on 8th August, 1918, is good reading, but it is impossible to review this important work in the time available and it is hoped that a suitable review will be published later. The volume will, no doubt, find a place in all reference libraries. It can be obtained from Australia House and from all booksellers. The price is 215.

F.E.G.S.

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" THE WAR ON THE CIVIL AND MILITARY FRONTS." By Major-General G. M. Lindsay, c.b., c.m.g., d.s.o.

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(Cambridge University Press. Price 5s.)

This booklet contains the Lees Knowles Lectures on Military History for 1942. The author, who delivered the lectures at Cambridge, is well-equipped for the task, as not only was he a machine-gun expert during the last war, but since then he has devoted himself to the study of Armoured War and commanded armoured units. After commanding a Highland Division for six months at the outset of the war, he was appointed Deputy Regional Commissioner, South Western region, and gained valuable experience in the German raids on Plymouth. General Lindsay thus writes with a wealth of first-hand knowledge, and every page of the lectures contains matter for consideration.

of first-hand knowledge, and every page of the lectures contains matter for consideration. Commencing with the features of modern warfare, he explains how from the results achieved with tanks at Cambrai in 1917, and at Amiens in August, 1918, a tentative plan was evolved in the summer of 1918 for a blitzkrieg to be held in April, 1919, which it was hoped would end the war. This proposed blitzkrieg was in essentials the same as that adopted by the Germans in this war, and was, like the tank, the product of British brains.

The need for speed in communications, and especially with the R.A.F., is stressed, though a special Air Force for the army is not advocated. The author insists on the necessity for team work between the armoured and unarmoured forces in the attack, and the immediate exploitation of any weakness in the energy's system, with the corollary that command and control must be decentralized and the utmost initiative encouraged among the junior commanders and even privates.

The deficiencies in our equipment at the outset of the war are pilloried, and saddled on the unfortunate British public. This in spite of the fact that Lord Hankey has recently stated that the chiefs of the three services kept the government fully informed of the progress of Nazi rearmament, and that Lord Baldwin admitted publicly that had he told the country the truth he would have lost the ensuing election. Dealing with the employment of armoured forces, the most question of supply by air, the varying purposes for which tanks are designed, and the main object of the armoured force, *i.e.* the break-through and the destruction of the enemy's armoured troops are discussed. On page 33 General Lindsay gives a picture of a break-through attack against an enemy strongly entrenched. It is interesting to see how this method has worked in the mastery over armour, as foreshadowed in the Flesquieres incident at the Cambrai battle in 1917. He further advocates the tide idea (the soft spot tactics of the last war) and above all the cultivation of the fighting spirit. Then follows an analysis of the German doctrine of armoured warfare, many details of which are given in F. O. Miksches' *Blitzkrieg* reviewed in this journal in December, 1941.

Turning to the defence of Britain and the civil front, there is a very useful summary of the various Civil Defence services, with their roles and duties. General Lindsay is sure that a blitskrieg to destroy Britain will be the last throw of the Nazis, and urges us to leave nothing undone to prepare for it. He considers that every able-bodied man in the Civil Defence services should be trained to arms. This was strongly advocated when the Home Guard was first formed, and especially so later on when the C.D. services were dressed in blue instead of khaki, as they should have been-but without avail. Close liaison between the military and civil authorities from regional headquarters down to parishes is the best guarantee for efficiency, but is not always easy of attainment. Other items of interest are the organization of a command headquarters and regrouping so that the higher authority will have fewer subordinates to deal with, the necessity for traffic control, the effect of bombing on towns of different sizes and a well-deserved tribute to the Women's Voluntary Services.

As stated above, these lectures are well worth reading, containing as they do the result of General Lindsay's long study and experience.

C.G.F.

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MACHINE WARFARE.

AN INQUIRY INTO THE INFLUENCES OF MECHANICS ON THE ART OF WAR. By MAJOR-GENERAL J. F. C. FULLER, C.B., C.B.E., D.S.O., late 43rd (Oxfordshire and Buckinghamshire) Light Infantry.

(Hutchinson & Co. 1942. Price 8s. 6d.)

General Fuller has written twenty publications on War in the last twenty years but his writings have had more influence on the Continent than in this country. In France no notice was taken of them, but in Germany the author had the best evidence of their influence when Hitler himself said to him at a review in the Charlottenberger Strasse "I hope you are pleased with your children." In England after twenty years of experiment we could only show in bulk the light tank, which General Fuller does not look upon as a tank at all, but merely an indifferent armoured scout, " a kind of mechanical mouse." These, he tells us, were the only tanks the B.E.F. took out to France in September, 1939.

The author traces the history of machine weapons from the introduction of cannon----"the first one-cylinder internal combustion engine" —in the fourteenth century, and in time comes to the revolution in tactics brought about by the aeroplane and the tank. The aeroplane has added the third dimension to the battlefield, but when not in fight demands protection of its air-fields, in which he asserts that the tank is its complement.

After describing the campaigns in Poland, Norway, Holland, Belgium, France, he quotes Axel Heyst to assert that Britain, opposed to so long a hostile coast line, from being a blockading Power is slowly moving towards the position of a blockaded one. The secret of the German plan was Velocity—the speed with which a defensive line was penetrated and the speed of the inundation which poured through.

His criticisms of the Russian war amount to this, that for the first time the Germans came up against an army almost as well equipped and undoubtedly as stubborn as themselves. When examining the tactics of this vast campaign he suggests that their key is "Salients, their creation, their attack and their defence." His examination of this on pages 172-176 is well worth reading. His forecast has been confirmed in the Battle of Alamein, in which if General Montgomery had been able to outflank both ends of the base of the Salient, his victory might have been decisive.

As to bombing raids, judging by the effect of the raids on this country, General Fuller is not enthusiastic; he considers that a continuous stream of small raids on a fixed number of targets kept up for a long period would hamper production and lower morale to a greater extent than spasmodic full-scale attacks.

He ends his book with very brief notes on the lessons of war and its study which he has from time to time jotted down. They are seventy in number and are evidence of an amazingly fertile brain. His book was written in 1941 and he may during the present year have seen the correctness of many of his theories.

H.B.B-W.

1942.]

THE WAR MOVES EAST. By Strategicus.

(Faber & Faber Ltd. Price ros. 6d.)

This fourth volume of war history covers the period from the fall of Smolen^{*}k (16th July, 1941) till the loss of Singapore (15th February, 1942), and according to the author was the most difficult to write, owing to the absence of definite information and for security reasons. In spite of the many dark moments and setbacks for the Allies, and our failures are not minimised, "Strategicus" considers this the most interesting period of the war. The bright spots during these months were the Russian counter-offensive (from 6th December, 1941 to 31st January, 1942) and the Libyan campaign on the 18th November, though both were only crowned with partial success.

Of most interest to the reader at the present time will no doubt be the account of the latter. The author claims that we gained a great success against odds, because we thoroughly deserved it. Undoubtedly we made the mistake of not keeping our armoured forces more concentrated. This was however the first time in our experience that a battle took place between armoured forces on a terrain which made the clash resemble a naval action at sea, and such an error was to be expected. Rommel committed the greater slip in sending off his tanks on a raid round our rear, and by so doing missed the great opportunity of inflicting a deadly blow on the dispersed forces of his opponent.

High and well-deserved tribute is paid to General Auchinleck for his conception of the battle and for his handling of the situation, when matters went awry. Though we failed in the first impact to destroy the enemy's armoured force, we defeated him and drove him back to El Agheila. That we could not consolidate our position there was due to the difficulties of maintaining supply across 300 miles of desert. This has been the crux so far in all the Libyan campaigns and it is to be hoped that a solution will have been found before our next venture takes place.

have been found before our next venture takes place. "Strategious" in his chapter on "sea and sky" emphasizes the importance of sea power and of air support in naval tactics, lessons which, judging from recent actions in the South Pacific, our Allied commander in these waters has thoroughly grasped. On Singapore the author comments that under the conditions existing at the time it was incapable of defence, but why was a division landed and supplies disembarked only to surrender them.

This book cannot have been easy to write, but it gives a clear description (with adequate maps) of a dangerous period in this war, which does not seem likely to recur.

C.G.F.

ARMIES ON WHEELS. By S. L. A. MARSHALL. (Faber & Faber Ltd. Price 78.6d.)

According to the author, this book is tentative in most of its judgments, and contains not so much conclusions as ideas. The first half gives an account of the campaigns in 1941, and singles out for special praise as classic battle studies the three following :--Wavell's operation against Graziani's Army in Libya, the courageous advance of the ill-equipped Greeks into Albania in face of a superior and well-found Italian Army, and thirdly, the German invasion of Serbia, when von List's two armies advanced simultaneously on Salonika and the Monaster gap, a manœuvre rendered possible only by the subservience of Rumania and Bulgaria. In the Russian campaign the Germans did not attain complete success because the country was too large for the forces employed, and they found it impossible to make a continuing and unlimited offensive, which is the essence of *blitkrieg*. In the author's opinion the campaign was jeopardized by the Germans not having sufficient motorized infantry divisions to accompany the armoured divisions.

More interesting is the second part on the nature of mechanized power. The chapters on the "return of the infantry" and "tanks can be stopped" foreshadow the struggle that has taken place between the Don and the Volga for the capture of Stalingrad. In spite of increased armour on their tanks, supported by massive artillery and bomb concentrations, the Germans cannot batter their way to victory against the Russian infantry and artillery. They have already taken nearly three months to advance over a distance which in France they covered in two days. Gun power is resuming its mastery and the tank has almost reached the limit of armoured protection. Moreover the Germans by employing their tanks as battering rams instead of using their mobility to find a way round, are not getting the best benefit from them.

The author harps on the necessity for a balanced army, in which mobility and power in the anti-tank wing are equal approximately to that of the tank wing, as only thus can the ups and downs of present warfare be weathered. He considers that, as heretofore, the fighting spirit counts most in war.

An opponent of an independent air force, Mr. Marshall, maintains that a modern

battle is a team problem, and undivided authority over it must be held by the ground commander. This solution appears to be the one we have adopted in Libya.

In the preface high tribute is paid to the foresight of Major-General J. F. C. Fuller regarding mechanized warfare, and his "Lectures on F.S.R. III" are freely quoted. The reader will find plenty of ideas in this book, and many of them are taking practical

shape as the war progresses.

C.G.F.

GERMAN INDUSTRY ON THE WARPATH 1860-1939.

By BERNHARD MANNE.

(Hutchinson, Price 18.)

This is a "Fight for Freedom." publication and describes in sixty-four pages of close print the influence exercised on the predatory governments of Germany from the days of Bismarck to the present time by the great industrialists, financiers, Junkers, and landlords. Perhaps the most interesting part of the book is that which shows how, after their defeat in 1918, the Germans set about a large-scale modernization and rationalization of their worn-out productive apparatus, and financed it by their famous Inflation Swindle, by which incidentally they fought their victorious battle against Reparations. Further help to them was given by foreign loans. Of these our author gives as a conservative estimate that whereas Germany paid in Reparations ten milliard marks, her public and private foreign loans amounted to twenty-eight milliards. The common folk in Germany may have been ruined, but the fortunes of the industrialists rose to greater heights and much of their industry camouffaged their war preparations, in which throughout all the years under review they worked hand in hand with their Governments. Their plunder in the present war has been great—will they get away with it ?

F.E.G.S.

SWORD OF BONE.

By ANTHONY RHODES.

(Faber & Faber, Ltd., 24, Russell Square, W.C.1, Price 8s. 6d. net)

The author (a member of the Corps) writes in a most interesting manner of his experiences with an Engineer unit of the British Expeditionary Force in France during the period from September, 1939, to the evacuation from Dunkirk. His work as billetting officer of his unit brought him into personal contact with many of the inhabitants and these are described in an amusing way. Records of various tours, including visits to the Maginot Line and to Paris, give a firsthand impression of life on active service whilst not in touch with the enemy. When, however, in May, 1940, the German attack began and the British forces had to withdraw towards the coast, the book becomes of absorbing interest and the last few chapters give vivid impressions of the courage and endurance displayed by our men during that perilous time, culminating in the embarkation from the Dunkirk beaches. A sketch map of the route followed by the unit would have added to the interest with which the book will be read.

J.H.

THE GREEN CURVE OMNIBUS.

By MAJOR-GENERAL SIR ERNEST SWINTON (OLE LUK-OIE).

(Faber & Faber. Price 8s. 6d.)

Another honour has been conferred on General Swinton, that of the O.E., the Omnibus Edition. In the volume just issued are twenty-four tales which have appeared in *Blackwood*, the *Strand Magazine* and *The Cornhill*. The dates of publication are given and are good evidence of intelligent anticipation. The series begins with the celebrated *Green Curve* and the *Second Degree*, and ends with D^2 , written in 1922, but not, the author tells us, published until 1934, when it was quite clear that the method of conquest by threats of frightfulness would not put a new idea into the minds of the General Staffs of potential enemics.

Every tale, although some of them are about the South African War, even My Matinee Tea, which has the sub-title of The Counter-Offensive, carries words of wisdom and contains instruction without tears to the young, a valuable reminder to those of riper years, and amusement to all.

MAPS PUBLISHED BY THE ROYAL GEOGRAPHICAL SOCIETY.

We have received from the Royal Geographical Society, a set of three maps which have been prepared by that Society for the British Council. They have been made in accordance with a suggestion of the late Lord Lloyd, then (1940), President of the British Council, that the Society should make a map in Arabic characters of existing and possible war areas. These three maps are in English; the Arabic edition is not yet ready. The map surface of each sheet is 36 by 23 inches, and the three can be mounted together obliquely. No. I shows Europe and the Middle East; No. 2, the Far East; and No. 3, North America to Britain. No. I is complete in colour; No. 2 and 3 are in outline only, but they will be completed later in the style of No. I. The price of No. I is 5 shillings; or No. I, with 2 and 3 in outline, may be had together for 8 shillings.

of No. 1 is 5 shillings; or No. 1, with z and 3 in outline, may be had together for 8 shillings. The whole series extends from a little north of 70° N. to a little south of 10° N., a stretch of 80°, but the calculation of the projection was confined to the space between 63° N. and 15° N., a stretch of 48° only. The projection adopted by Mr. A. R. Hinks is that known as Murdoch's Third Conical Projection, in which the meridians are true to scale, and the area of the zone between 63° N. and 15° N. is correctly represented. The scale along the meridians and along the parallels of 55° 6′ 50° and 26° 53′ 46″ is



1 to 11 million, or about 174 miles to one inch. The projection is a very suitable one for the purpose, and was, no doubt, originally calculated for sheet No. 1.

This sheet is complete so far as the English edition is concerned. It is a very pleasantly coloured map which shows the main physical forms well. An important feature is that the layer tints, of which there are twelve, are all in one colour and are printed from one photogravure plate. The result is harmonious and happy, and is appropriate for a map on this very small scale. The contours, which are in firm, brown lines, are at 50, roo, 200, 500, rooo, metres above sca level, and afterwards at every rooo metres. A hill-shading plate in grey is superimposed, the light being supposed to come from the top left corner; the result is very effective. The chief adverse criticism which might be made is that there has been over-printed, on top of the delicate layer colouring, a plate in brown, which represents sand deserts. This brown plate does considerably interfere with the effect of the layer gradation of colour, and perhaps in another edition might be replaced by some other symbol.

The map is essentially an excellent physical map, and, though political boundaries are there, they must be hunted for through a magnifying glass. Mr. Hinks gives reasons for omitting borders on the map; a minor point.' A useful innovation is the printing of scale values along the parallels, off the map, in the margin. Thus alongside of parallel 63° N. will be seen the figure 1.063, indicating that the scale along 63° is too large by 6.3 per cent. Many other interesting features might be mentioned, such as the system of transliteration of the names. An important point is that the map is printed on a very strong paper, which has passed stringent tests for folding and tearing. Altogether an excellent map, on the production of which we may congratulate the Royal Geographical Society, and Mr. Hinks, who was chiefly responsible.

C.F.A-C

MAGAZINES.

JOURNAL OF THE UNITED SERVICE INSTITUTION OF INDIA.

(April, 1942.) A Gurkha with Lawrence recounts the experiences of a small party of a Gurkha regiment, which joined Lawrence and his Arabs, and incidentally Indians, French Artillery and Egyptian Sappers and Miners, in the final stages of the advance along the Hejaz railway. The Gurkhas were for the most part engaged on railway and telegraph demolition behind the enemy lines. They rode on the unfamiliar camel, and had chieffy atta-almost equally unfamiliar—to eat, but conditions seldom allowed the lighting of fires for cooking it.

There are two articles by Rasp. In Wartime and Post-war jobs he points out that though the outbreak of war reduced the number of officers coming Home from India on retirement to a mere trickle, its long continuance must of necessity mean that the stream grows to something like normal volume, and that therefore many officers will be looking for ways and means to supplement a pension which Income Tax has reduced by nearly half. There are many useful hints and warnings. Poultry-keeping, vegetableraising and apiculture are touched on, and the few paid jobs in the Home Guard enumerated. One useful wrinkle is that officers should learn to do their own household repairs, and so save builders' and plumbers' bills. In Price marches on he dwells on the increased cost of living in the United Kingdom,

In Price marches on he dwells on the increased cost of living in the United Kingdom, and comments on the difficulty of making ends meet. It is desirable to read this article before the other.

Lieutenant-Colonel R. B. Phayre, M.C., is one of the lucky few to have been favoured with a Visit to Nepal. His descriptive powers are good, and give one a fascinating description of the land of the Gurkhas. A remarkable fact recorded is that during the Nepal War of 1876, wounded Gurkhas would stagger from their lines to be treated by our doctors, and when that was done, go back to their own people to continue the fight.

The Indian Educational System comes in for some criticism in relation to the requirements of the Defence Services. The average Indian University student is found to be lacking in elementary general knowledge, powers of observaton, inquisitiveness and alertness, all very necessary for candidates for commissions. He is apt to treat lectures as suigeneris and fails to realize that their object is to train the hearers to tackle problems in the field. There are many useful suggestions.

Jungie Interlude is the tale of a trek through very wild country abounding in bison, elephant and tiger.

Infantry Platoon Organization and Tactics criticizes the present Indian platoon on the ground that the section leader, the most junior commander in the army, has to command ten men, a number which is acknowledged to be beyond the capacity of superior officers. The author's suggestion is four sections of one and five, with an increased number of L.G.s and tommy guns. It would certainly seem to make for a more workable unit.

Struma Valley, 1919, relates the experiences of some British Officers, who had noted its possibility as a shooting ground for birds at a time when more serious matters rendered such sport impracticable. The matshes proved almost impenetrable, and though much game was shot, it all came to a (literally) bad end. The help and kindness they received from Greek officers in the district were beyond praise.

Defence and Dispersion deals with the best method of holding a locality, the moral being, do not do so in penny packets. There are few concrete suggestions, the absence of which should stimulate the reader to think them out for himself.

F.C.M.

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INFANTRY JOURNAL

([uly, 1942.)-Destruction of an Army. Part I. The Italian Advance.

This is a reproduction of a British account of the first part of the Libyan campaign. It begins with a description of the country and climatic conditions in Libya, and then deals with the Italian advance against Egypt, which began on September 13th, 1940, by an attack on Sollum. The Italian army under Graziani advanced as far as Sidi Barrani and then stopped. Graziani made no further advance for three months, and was then forestalled by the British counter-attack on December of

was then forestalled by the British counter-attack on December 9th. All this is a matter of history, but it is interesting to recall some of the work carried out by the Royal Engineers in those early days of the Libyan Descrt campaign. Success

depended largely on providing an adequate water supply for the troops. The desert is practically waterless except for a strip, 30 miles wide, near the coast. Here the water from winter showers collects in the porous rock beneath the sand dunes. The rock, only three feet thick, rests upon a substratum containing salt water filtered in from the sea. Hence it is impossible to sink wells. The ancient Romans overcame the difficulty by making a net-work of stone-lined aqueducts, into which the fresh water could trickle without coming in contact with the salt water below. In the intervening centuries most of their work was buried and forgotten. By cleaning and repairing the old aqueducts the R.E. were, however, able to secure enough water for the use of our troops during the campaign.

From the beginning the Royal Engineers had been working on defensive preparations at Matruh and elsewhere in the vicinity, and the construction of concrete pill-boxes. anti-tank ditches, mine fields, and other defences was pressed on continuously. This entailed providing and moving quantities of stores, maintaining hundreds of miles of roads, and, to supplement the water supply, laying many miles of water piping and

installing pumping plants. When, early in September, it became obvious that the Italians intended to advance through the Halfaya Pass towards Sollum, which had been evacuated by our troops, the R.E. were actively employed on work to hamper the Italian advance. They mined roads, salted water supplies, and tore up the coast road, which would have been a vital line of supply to the enemy, sowing the resultant rubble with land mines to add to the difficulty of repair. The work proved of great value in delaying the enemy's advance to Sidi Barrani, and in holding up his further progress from that point. Other articles of general interest in this number are : War in Snow and Extreme Cold,

Gas in Modern War, and America and the Coalition War.

Under the heading International Military Survey, there is a review of Major de Seversky's book Victory through Air Power, a book that has caused a good deal of stir lately on account of the writer's original ideas. The reviewer states that Major de Seversky tries to drive home two points. Firstly, that the way to win the war is to build fleets of great bombers, which will be able to destroy distant nations without ever occupying them. The huge planes would keep on dumping bombs, day after day and month after month, until the hostile nation had been cancelled out as a source of armed power. Secondly, that Major Seversky knows how to use air power to win this war, and that the high military authorities—both our own and those of our enemies—in general do not.

The reviewer has a good deal of criticism to offer on the first point and is very scathing with regard to the second one.

(Septimber, 1942.)—Machine Warfare. By Major-General J. F. C. Fuller. General Fuller's views on mechanical warfare are well known. This is the first of a series of three articles in which he expounds his latest ideas on the subject.

Street Fighting. By Bert Levy. In view of the heavy fighting that has recently taken place in Stalingrad, this article is of special interest at the present moment.

The necessity for training troops in street fighting is emphasized. Casualties are always very high, but the advantage is invariably with the defenders. Whether the town has been previously bombed or not, buildings provide excellent cover. Enemy tanks can do little, nor can the enemy's artillery or dive bombers have much effect once the enemy has entered the town.

In the defence of a city all approaches must be prepared to resist the initial attack by using road blocks, land mines, pill-boxes, strong points on all advantageous ground, cross trenches and fox-holes along all roads, and other similar measures. In preparing strong points for resistance, they must be placed so that they can be enfiladed by straight, cross, or converging fields of fire from other strong points. Enemy armoured vehicles will leave the main roads when they are held up and will attempt to by-pass strong resistance. If the enemy does capture and occupy a strong point, concentrated fire from all other points can immediately be brought to bear upon it. The first ring of defence of a city or village should be a ring of strong points some distance out from it. The second ring of defence consists of all strong points and buildings on the outskirts, but there should also be plenty of strength between rings, and then concentric rings within.

If a town is to be converted into a fortress, serviceable barricades will have to be erected. These may consist of unusable vehicles, turned over, with their wheels removed, or of large trees, sawn nearly through, and pulled across the road. Flimsy barricades are useless, but barbed wire, if used in large quantities, is very helpful,

Concrete blockhouses and sheet-iron shelters, placed inside the rooms of fortified houses, provide cover to the garrison during the preliminary bombardment. Rugs or blankets hung across a street will provide cover from view, and will enable troops to carry out movements otherwise impossible except at night.

In attacking a house, troops should be trained to try to seize the top floor as soon as they get into a house. It is always a good rule to be on top of your opponent. Progress from one room to another may be made by a system of mouse-holing. A small hole is made in a wall or floor with a pick or crowbar, a grenade is tossed through it; the hole is then enlarged, and a second grenade is tossed through to ensure that all the occupants of the room have been killed. Mouse-holes may of course be used as loop-holes or for observation.

As regards weapons, rifles are most useful as snipers' weapons from upper rooms; machine-guns and tommy-guns are most usefully employed on the ground floor.

It is very helpful if men are trained to fire from either shoulder; in some cases it is only possible to use cover by firing from the left shoulder.

Many other suggestions are made that can be of practical assistance in street fighting ; it is largely a question of ingenuity and originality. In the German attack on Warsaw tanks proved of little value. Polish civilians and half-trained recruits with poor fortifications defeated a German armoured division which reached the suburbs of the city at the end of the first week of fighting, and they did this entirely by improvised methods. The methods used by the Poles threw Reinhardt's Panzer division and its supporting troops out of the Warsaw suburbs in twenty-four hours. And they stayed out until the main German army came up many days later.

There is an article on Alaska, a country that may figure in the news to an increased extent in the war with Japan. Alaska came into the possession of Russia in 1741. Having got as much as possible out of the country, especially in the way of sea-otter furs, the Russians sold it to the United States for seven million dollars. It proved a good bargain to the Americans, although the development of the country proceeded very slowly.

The three main industries of the country are (1) fisheries (mainly salmon), (2) gold, (3) furs, in the order named.

Communications are poor. Much Alaskan traffic still moves on the rivers. The only highway worthy of the name is the "Richardson Trail" which connects the port of Valdez with the inland metropolis : Fairbanks. An extension of the Richardson Trail connects Fairbanks with Circle, on the Yukon River. The one important railway connects the port of Anchorage with Fairbanks. Another little railway runs from the port of Skagway to Whitchorse.

No mention is made in the article of the new highway from Canada, constructed during the present war and recently opened to traffic.

In Part III of War and Snow and Extreme Cold there is a detailled description of the construction of a domed snow-house by the eminent Arctic explorer, Dr. Vilhjalmur Stefansson.

A.S.H.

REVUE MILITAIRE SUISSE.

(March, 1942.)-Les sapeurs au combai. By Colonel H. Lecomte. A summary of two articles in the Technische Mitteilungen für Sappeure, Pontoniere und Mineure by a Captain Kollbrunner. The object of the articles is to point out how the sappers of today may be used as picked fighting men, while still preserving their role of skilled workmen. Some illustrations of this are given in the case of small parties of Sappers detailed to accompany raids, assault detachments or counter-attacks. The right balance between using up sappers as infantry and getting the best results from their skilful use as Sappers trained to fight is the problem.

Commentaires sur la guerre actuelle. The American production of war materials is the subject of this month's commentary. The writer is evidently sceptical of the American effort. Month by month the Ailies were proclaiming the near approach of the turning of the tide by the swelling of the American output, but month by month the situation worsened, as the Axis Powers swept over country after country, gathering more momentum and harnessing the industries of fresh-conquered peoples. Quoting such journals as the American "Life" and "Picture Post," the writer is somewhat scornful of the figures of gigantic production and of the stream of planes, tanks, guns and ships which were to become a stream, a river and then a flood. He does not want to realize that the stream was growing every month. There is a distinct Axis flavour about the commentary.

(May, 1942.)—Pionniers d'infanterie. By Colonel H. Lecomte. In the April number of this review (sec R.E.f. Sept., 1942) Colonel Lecomte wrote on "Questions du Genie" and concluded by saying that it would be a good thing to form companies of "fighting sapers." Another writer, Captain Brunner, in the Schweizer Soldat formulated much the same idea ; he suggests a company of infantry pioneers in each infantry regiment. Colonel Lecomte reminds him that these companies were formed in the Swiss Army in 1874 but were disbanded in 1891. He himself has constantly advocated their re-appearance but with no success.

In 1874 each company of infantry was given 4 sappers, with 1 N.C.O. per battalion,

and a mounted officer per regiment. These sappers were trained by the engineers, and their duties were to carry out the more technical embellishments of the formal fieldworks of those days. Such a miserable skeleton soon broke up, and the sappers of a regiment were formed into a section; then the 4 regimental sections became a divisional company ; so by 1891 the divisional pioneer company had taken the place of the 4 sappers per company of infantry.

The company shared the common fate of engineer units in peace training ; they were forgotten in orders and billeting schemes.

In 1907, the 2 companies were increased to 4; today there are 3 to a division.

The reasons for reverting to the infantry pioneer system are not clear. The difficulties

of a uniform training of such isolated sections seem to far outweigh the advantages of close contact between infantry and sappers. The close contact can still be assured. *Commentaires sur la guerre actuelle.* In May, the Germans' great spring offensive had not yet begun; but there was plenty of activity in the East. The invasion of Burma, the occupation of the northern tip of Madagascar, and the invasion of the Dutch East Indies by the Japanese drew attention away from the Russian theatre of war.

The defence of Burma was of supreme importance for the Allies, for the loss of the Burma Road meant the practical isolation of China from the Allies, and China was still the main objective of the Japanese.

The rapid advance of the Japanese destroyed the British hope of holding Mandalay until the monsoon broke. The disloyalty of a part of the Burmese people added to the British difficulties.,

In Europe, the constitution of the second front had not yet begun, for want of the necessary means. The problem of sufficient sea transport remained the crux of the situation. Clearly any landing, on a sufficiently large scale, must be supported by a continuous naval and aerial superiority. But the threat of invasion was obliging the Axis to use considerable forces to guard the coasts. Von Runstedt had been sent to France to take charge of the defence ; Heidrich had been sent to Paris to dominate the civil unrest.

The growing air attacks on Germany could not be regarded as the second front. They forced the Axis to keep large air formations in the West, particularly night fighters, but they did not relieve the pressure of the great German armies against the Russians.

The Russians were attacking in the Kharkoff sector, while the Germans had taken the Kertch peninsula. The final decision on the eastern front was not expected in 1942.

(June, 1942.)—A propos du pionnier de l'infanterie. By Major Nicolas. A rejoinder to Colonel Lecomte's recent articles on the infantry pioneer. The writer thinks that this is not the time to open a controversy on the training and organization of the Army, but he takes up the cudgels because he thinks that Colonel Lecomte is preaching a dangerous doctrine. He holds it to be an error to try to combine in one individual the sapper and the shock-trooper. Not that he wishes to doubt the capacity of the sappers, but the training of the assault troops requires to be so intense, and so long that it is vain to try to make the sappers do all this in addition to their technical training. Every man to his trade !

The old traditions of the battlfield have no application to the battlefield of today. There was no fury from the air. The upkeep of communications today demands all the energies of the sapper companies. Formerly, the assault of fortresses was only an incident in the campaign; often a rare incident. Today, the attack of strongpoints, trenches, and tanks is continuous. The anit-tank gun must be the normal weapon of the infantryman.

It is not the creation of pioneers that is wanted, says Major Nicolas, but the complete recasting of the methods of training of all arms-especially of the infantry-to adapt themselves to the new conditions of war,

L'action italienne dans la guerre balkanique. By Lt.-Col. Dominici. A short account, by an Italian officer, of the Italian operations against Greece and Yugo-Slavia. Italy had no designs on Greek territory, says the author; she only desired to secure strategic positions on the Balkan Peninsula in order to safeguard her flank on the Adriatic.

At the beginning of the campaign in 1940, the Italians had only 5 divisions against almost double the number of Greeks, but no mention is made of the superiority of the Italians in tanks and aircraft. Heavy reinforcements were on the way from Italy.

The Greek Army is stated to have been armed and equipped by England; the air force and anti-aircraft defence were English ; 60,000 British were on Greek soil ; but the author implies that all this assistance was there at the opening of the campaign.

The Italians attacked and surprised the Greeks in the course of their deployment ; the Greeks immediately replied with a counter-offensive which drove the Italians back into Albania, and kept them there until the threat of the German concentration in Bulgaria forced the Greeks to weaken their army in Albania.

Great valour and heroic sacrifices are claimed by the author for his countrymen ; rather too much stress is laid on the success of the Italian counter-offensive, which after all did not take place until the Germans arrived on the scene.

By April, 1941, the Italian forces in Albania amounted to 26 divisions, 3 regiments of

Cavairy, 4 of Bersagliere, 1 of Grenadiers and a group of Black-Shirt battalions. Some 7 divisions of this force were employed against Yugo-Slavia.

With the fury of the German onslaught on Yugo-Slavia, it was impossible to contend, and the Italians had little more to do than to follow up and occupy the country.

No details are given of the fighting. The Italians casualties are given as 13,502 killed, 35,76S wounded, and 17,547 frost-bitten; the latter a remarkably high figure, pointing

to inadequate treatment, or inadequate preparation for the winter campaign. Commentaires sur la guerre actuelle. The year's campaign against Russia is reviewed. The Germans began the campaign in the belief that it would be all over in three to four months. The Russians were expected to revolt against their rulers. Time and again the Russian armics were reported to be annihilated. At the end of the autumn of 1941, Dietrich was proclaiming from Berlin that the decision had already been obtained, and that the Red Army no longer presented any danger. The great offensive against Mos-cow in October was to be the *coup de grace* to the Soviet. But Moscow was not taken, and in December, the German High Command announced that the offensive had been halted, and would be renewed in the spring. The German winter defence line was anchored to a series of strong localities which prevented the Russians from gaining all the conception and the best which prevented the strong strong gaining all the success they expected when, during the hard winter months, their Armies courageously hammered at the Germans, and, between the strong localities, regained large tracts of their country.

The spring came, but no Hitler offensive. Instead, the Russians themselves opened an offensive at Kharkoff, designed to forestall the German attack. Von Bock was obliged to make a counter-attack, but not in the direction intended.

At the end of a year, that is to say, in June 1942, the struggle against Russia had developed into a race between the Anglo-American aid to Russia and the German effort to obtain the decision before this help reached its maximum,

W.H.K.

THE INDIAN FORESTER.

(May, 1942.)—There is little in this number to remind one of the unpleasant proximity of war to India, for example, an article on the rafting of logs down the Irrawadi does not mention the nearness of the Japs, who have presumably upset all the arrangements described therein; the article is not the less interesting for that.

Containers for various solids and viscids, such as grease and paint, are now being made in India of plywood, with capacities up to 5 gailons or 36 lbs. Experiments are being made to replace the familiar kerosene oil tin with a plywood ersaiz.

Forest Administration Report, Bombay, 1940-41, mentions a cyclone which uprooted or broke three million casuarina trees in one division alone (North Thana). We gather that this otherwise untimely felling occurred opportunely to help the war effort.

5-ply boards for aeroplanes are now being made to a thickness of 6 mm. Allowing for the necessary thicknesses of glue, each board must therefore gauge at something less than 1 mm.

(June 1942.)—Poeciloneuron indicum is a timber said to be available in commercial quantities in the everyteen rain-forests of Mysore. As it is said to be as strong as teak, although considerably lighter, it may be worth studying. It is not readily attacked by teredo and is moderately durable. Vernacular names given are *pali* and *balagi*.

A note on controlled grazing in the Kamrup division of Assam records how an area of coarse thatch which cattle would not eat was cleared; sait was sprinkled over the offending stuff and then the beasts ate it greedily.

(July, 1942.)—The biological control of exolic weeds relates how the prickly pear was exter-minated over vast areas in Australia by means of a specially imported moth. This insect is a native of Argentina, and in a remarkably short time cleared some sixty million acres of land of the pest, restoring to Queensland and N.S.W. many hundreds of square miles of good pasture land.

The report of the annual convocation of the Indian Forest College relates how the Commandant of K.G.V.s. Own Bengal S. and M., in spite of the war, still instructs forestry students in field engineering. A novel use for the microphone is to listen-in for the borings of termites in timber.

They make a noise distinctly audible.

F.C.M.



AT no time in all history was there a more zealous, impassioned ecciesiastic than St. Dunstan of Avalon. Never has the Devil had a more redoubtable antagonist. Who has not read the story of St. Dunstan's encounter with the forces of evil on that memorable occasion when, so it is said, he gripped a pair of red-hot tongs and seized his arch-enemy by the nose.

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Although Dunstan was admittedly ambitious and something of an autocrat, historians are agreed that he was a great patriot and that his scemingly insidious scheming for personal advancement was generally at the expense of the foreign faction which, at that time, wielded considerable power in the country.

Certainly he was endowed with the crusading spirit; a spirit that has through many generations inspired his fellow countrymen to deeds of self-sacrifice and heroism. A spirit that still burns in the hearts of men in the present struggle against the forces of evil.

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