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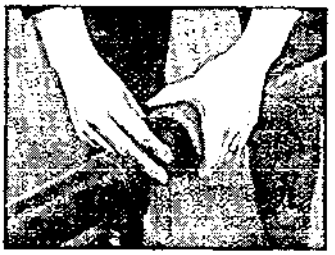

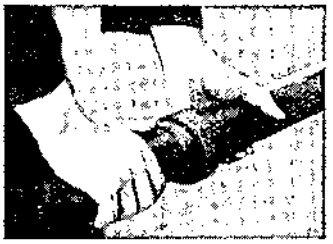

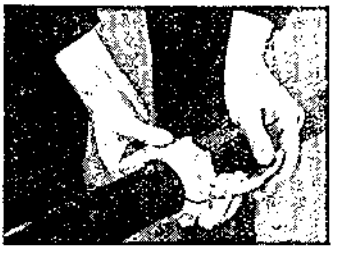

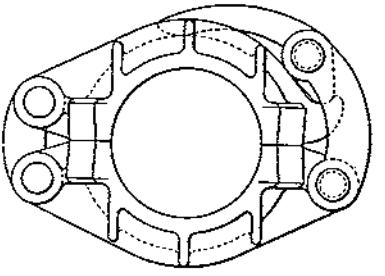

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in what was then called the Training Depot R.E. I was under orders to join the 11th Field Company and was looking forward to the happy programme of peace soldiering at Aldershot.

Mobilization, following the declaration of war on August 4th, 1914, soon shattered these dreams and Aldershot and the Training Depot became a regular inferno. Mobilization seemed to go like clockwork; Gibraltar Barracks was rapidly flooded out with reservists, officers, N.C.O's and men. About a dozen of us slept in the tin squash court behind the Mess, tents were erected on every grass plot in and around barracks, and the recreation ground was covered with horse lines—always excepting that oasis in the centre, the cricket pitch.

For the next fortnight we in the Depot sorted out, clothed, equipped, posted and started training our mob of reservists. The day's excitement as far as we Y.O's were concerned was whether orders would come for us to join a field unit or not.

The but recently-formed Field Squadron, Field Companies and Signal Units all entrained "according to plan"; we used to take working parties down from the Depot and help entrain these units at the military siding. I remember helping the Squadron in this way. One incident has impressed itself on my mind, that of the unfortunate Company Commander who, fortunately only temporarily, mislaid the key of his mobilization safe!

On 18th August my turn came and I was ordered to join the 9th Field Company at Harrow, and was sent off next day complete with my own charger and a batman from the Depot reservists, in a horse-box. Aldershot to Harrow is not very far, but it was a fearsome journey that day and was made *via* Reading, Reigate and the south coast of England! I managed to find Headquarters, 4th Division, at Harrow that day, to learn that the Division was in process of concentrating at Harrow, having handed over the defence of the east coast to the T.A. Finding a suitable inn, I billeted myself, horse, and batman there, giving the innkeeper an official form next morning, which I hope he eventually managed to turn into coin of the realm. Next day, about noon, the 9th Company marched into a field just below the Hill, near the School outdoor bathing-pond, and there I joined them. The next day was spent in packing and checking all the Company gear and was enlivened by a bathe in the School bathing-pond. Kits were cut down to exact text-book quantities and weights; about all we went out with beyond what we stood up in were our greatcoats and valises: the latter only contained a complete change of underclothing and second pair of boots—no blankets.

The same day my batman was returned to store, to Aldershot, it having transpired that he was a ticket-of-leave man having been released from Holloway on mobilization; in his place I was given a Driver Kenton. This driver was a reservist who had served through the South African War as a batman, and he turned out to be

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THE DIARY OF AN R.E. SUBALTERN WITH THE B.E.F. IN 1914.

By MAJOR B. K. YOUNG, M.C., R.E.

FOREWORD.

I MAKE no apology for this personal narration ; I have been told to do it by " one who must be obeyed "—so I hope this statement will disarm my critics.

This cannot be a history of the 9th Field Company, because it is only a partial account of the Company's activities ; my own humble doings were a very small portion of the total work done during this time. I do make apology, though, for the frequency of the word " I " and " my," but they are inevitable in such a diary as this, which only sets out to describe events in which the writer personally participated. Dates and places are not taken from any official sources, but from notes jotted down from time to time during the period in question. I would like to emphasize that when I say the Company bivouacked at a certain place, I don't always mean actually *in* that place but within a short distance of it ; halts, bivouacs, etc., must be tied into some name-place to localize them, and the use of the name of any village must be taken to cover a small area around that village.

Since finishing this screed, I have tried to confirm that Chevry was our final halt on the retreat—I am almost positive, but can only ascertain for certain, that Chevry was in the centre of the III Corps area of the night in question ; this is very fair corroborative evidence.

PART I.

MOBILIZATION.

IN July, 1914, I was at Aldershot, going through that most pleasant stage of the Y.O.'s education, namely, the Mounted Duties Course,

Frontispiece.

Bridge across the Marne at La Ferte sous Jouarre, 9th/10th September, 1914

Diary of an RE Subaltern

absolutely first class—I believe he stayed with the Company throughout the whole war.

Mention must be made, too, of the pride of our transport, namely, six grey horses, whom we confidently expected shortly to draw a pontoon wagon triumphantly through Berlin.

The 9th and 7th Field Companies comprised the 4th Divisional Engineers; the former came from Woolwich and the latter from Shorncliffe. At App. "A" is the "Order of Battle" of the Div. H.Q. and the Div. Eng.

Joining the B.E.F.

At 8.30 a.m. on August 22nd, the Company marched away from Harrow to a railway station at Park Royal—on, I think, the Great Western Railway. Here, again, the thoroughness and completeness of the Mobilization Scheme forced its notice on us. Park Royal was laid out with sidings, apparently solely for the use to which we now put them, and trains drew in just exactly complete in the different types of trucks to fit the unit to be entrained. Even our pontoons were simply and quickly loaded over end-loading ramps.

Southampton was reached about 1 p.m. and we embarked on a tramp steamer called the s.s. *Basil* at 4.30 p.m.—men, horses and vehicles. I think we shared the complete lack of any amenities in this steamer with a Field Ambulance. Soon after sailing, the troops were assembled and the King's message was read to them and they were all given a copy of Kitchener's letter (App. "B" and "C"). This stands out in my memory as an impressive moment—all the men clustered in the well of the ship with the O.C. Ship reading the message from the bridge. We had an uneventful crossing in the dark and next morning found ourselves at the mouth of the Seine. Close by was another tramp steamer, carrying, we soon found, the 7th Field Company. Pleasantries were immediately exchanged regarding a rowlock, a time-honoured bone of contention between the two Companies. Now that the 7th Company are back from the Rhine, and once more doing their annual pontooning at Wouldham with the 9th Company, I wonder if this old joke has been re-born! The s.s. *Basil* steamed on up the Seine to Rouen; it was a remarkable journey—we were literally received with acclamation by the population the whole way up the river. Rouen was reached late in the evening and difficulties arose at once—we found that each horse had to be slung out of the ship and that at the moment the cranes were not working. Either it was too late for the stevedores, or the pressure for the hydraulic cranes was deficient, or both; eventually disembarkation was completed and we reached Bruyère Camp sometime in the early hours of the morning. Westland's horse was one of the first slung ashore; his batman, imbued with the necessity of "showing the flag" unbeknown to us, saddled up, mounted and rode

off with his master's sword drawn! Speedy retribution followed —the *pavé* bringing his horse down. Hospital for the batman and a broken sword scabbard for a very angry master.

On the quayside we picked up or, I should say, acquired our interpreter—he couldn't have been picked up, he must have weighed 18 stone or so. He looked most warlike in the full French marching order, complete in blue coat and red pantaloons. His transport was a problem, he said he should be mounted, but obviously no horse we had could carry him. His accoutrements were put on the H.Q. G.S. wagon, and he was given a G.S. bicycle—and they were even heavier bicycles then than they are now; but that was no good, he burst a tyre! Eventually, despite his protests, he was told to walk, but he generally managed to climb on the G.S. wagon—he was thinner before the end of the retreat. He was a good fellow at heart, though. I wish I could remember his name. I believe he had been a commercial traveller in alarum clocks between London and Gravesend. He really wasn't a great deal of use: it took us a long time to understand his English, and his French must have been of some southern dialect, because he was not much of a success as a linguist with the northern peasantry.

At 4 a.m. on August 25th, we entrained—a very different experience from our former one at Park Royal—and for the first time made the acquaintance of *Hommes* 40, *Chevaux* 8. We moved off about 9.0 and the Company detrained in the rain at St. Quentin about 5 p.m., to the sound of artillery fire.

The rail journey was a repetition of our passage up the Seine, though closer contact was made with our Allies—the children already knew how to ask for bully beef and pennies. The Company moved off at once northwards through St. Quentin, the inhabitants of which showered flowers and gifts on the troops; in fact, the tool-carts began to look like a tradesman's delivery wagon. I don't suppose many of us thought, I certainly did not, that within 24 hours we should be retreating south through the same town.

Late that night we went into bivouac in a pleasantly-wet ploughed field and watered our horses by bucket from a tiny stream, a laborious job rendered more difficult by the sound and flashes of not too-distant gunfire, with which neither horse nor man was as yet familiar.

THE RETREAT—PART I.

This brief personal record makes no claim to be a connected narrative—that would be impossible; certain definite happenings stand out, but generally speaking, the "fog of war" was master of the situation, and the field company subaltern's knowledge could only be very local. My recollection now is chiefly that of a damnably long, wearying, bewildering trek in the wrong direction, punctuated

by periods of intense unpleasantness, certain definitely memorized events and a huge mass of indigestible rumours. Maps were non-existent; we had only been issued with maps for an advance, and we soon walked off these! For many days the only Company map was a French motor touring map, which I was fortunate enough to "borrow" from an unlucky refugee motorist.

However, to continue the narrative; next morning, at 6.30 a.m. (August 26th), we marched on north-east towards Le Cateau and must have joined up with the Division; at any rate, about 2 p.m., the column did an about-turn, leaving my section for rear-guard work. We retraced our steps through a now almost empty St. Quentin to Ham, where at about 2 a.m. my section settled down in the railway station. The next two days we got back to Sempigny *via* Noyon; the transport on the roads was terrific and the subsidized lorries of the M.T. Units added a touch of incongruity, as none had as yet shed their civilian names and advertisements, added to which their drivers had generally chalked up some facetiousness about Berlin and the Kaiser! A considerable thunderstorm made the roads worse; a mixture of lorries, *pavé*, pontoon wagons and the pitiable flow of refugees do not make for easy travelling. However, the German pressure on the Division seemed to have relaxed and it was, I think, at Sempigny that units sorted themselves out and regained their own individuality. The effect of this on morale was most stimulating and did much to counter-balance the terrible losses that had been suffered.

The afternoon of the 29th I was sent off on a water and bivouac reconnaissance with the D.A.Q.M.G. of the Division (Capt. H. J. Elles)—I only mention this, because I can remember even now the luxury of getting in a car and being given a real cigarette to smoke; we had been reduced to "produce of the country" for some time! The Company moved to Carlepont that evening and started off again at 2 a.m., by way of Tracey le Mont to Château La Chenove, about 1½ miles south of Trosly Breuil; soon after mid-day I was sent off with a party to blow up Compiègne bridge. I left the Company somewhere near Trosly Breuil. Late that evening (August 30th) the Company had orders to send back and blow up a bridge at Bailly, on the Oise. Why this bridge had not been blown up, I have never found out. Actually, on the 29th, it had been prepared for demolition by Westland, but under orders of 10th Brigade he had to remove the charges and leave the bridge intact.

[This same day, Fishbourne blew a bridge at Ourscamps.]

I have since been able to learn something more of the Bailly affair from Corpl. Stone, who was there badly wounded and captured. I gather that Fishbourne and party with an infantry escort were to go out in a lorry—the escort never materialized and the lorry was almost out of petrol. Fishbourne

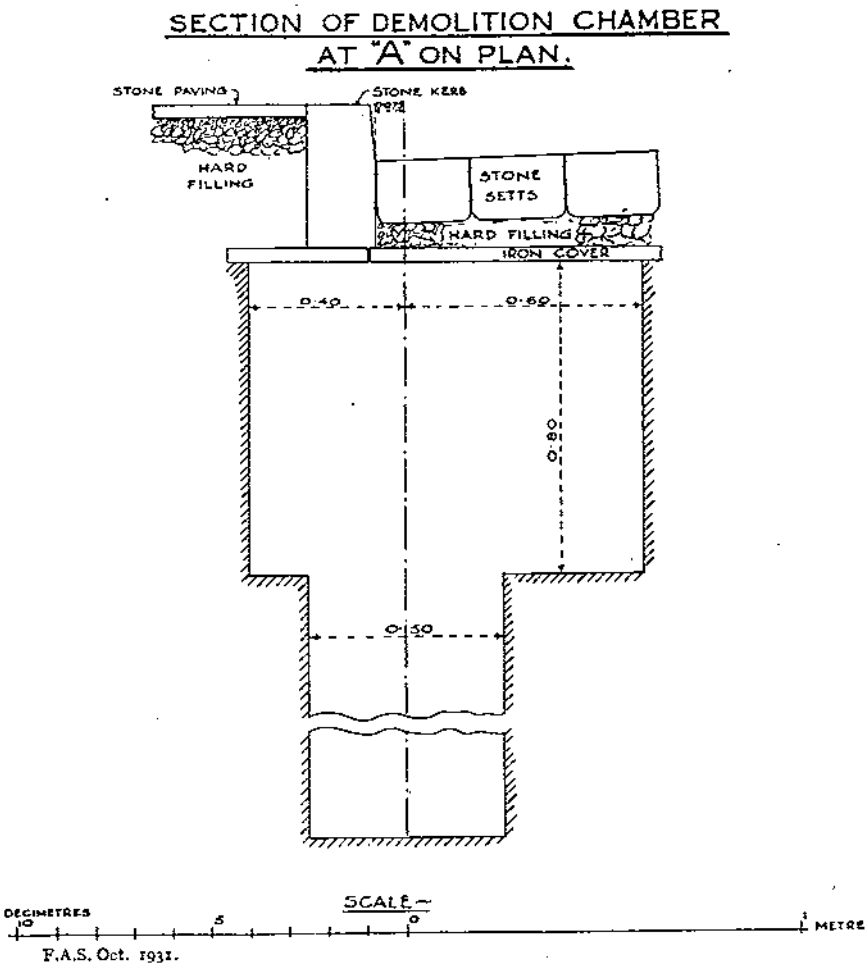
started off with the necessary explosives in the lorry about 9 p.m. Major Barstow, who had in the meantime found out where petrol could be had, followed up and joined up with Fishbourne's lorry. Of definite information about the enemy, or even the road, I think the party had none. They eventually halted the lorry and proceeded on foot in single file on both sides of the road. They were never to reach the bridge, though, the enemy had got there first and the little party was shot up, with their task not done. Major Barstow was killed, Corpl. Stone wounded and had to be left. Fishbourne was untouched and managed to get away and back to the lorry with the other three of the party, all of whom had been hit. That they got away at all can only be put down to the enemy not realizing that such a small party could ever have been sent back so far, alone and unsupported, on such a task. Apparently there was only a small enemy bridgehead on the spot; with a proper escort, this might have been brushed aside for long enough to enable the charges to be laid and the bridge blown.

COMPIEGNE BRIDGE.

Apparently I was sent off to deal with this bridge because my tool-cart had a few slabs more of guncotton left than had the others —anyhow, with my Section Serjeant (Serjt. Clements, who later won the D.C.M. at the Second Battle of Ypres and became C.S.M. of the Company) and some eight Sappers, we set off on bicycles, with the tool-cart. The road was fairly clear, being across the general line of retreat, and we did the odd 12 miles partly at a walk and partly at a trot, arriving somewhere about 5 p.m. We went straight down to the bridge and had our first look at it. I confess I was staggered; the bridge was more like Westminster Bridge than any of those bridges which we, as Y.O's, had all so skilfully demolished "on paper" in our peace-time training. Feeling pretty weary and rather having the wind up, Serjt. Clements and I dived for the *F.S. Pocket Book* in the tool-cart and reckoned out that to tackle one span at the haunches we wanted about 2½ tons of guncotton! The bridge was a very well-built stone affair of three arches, with two very solid-looking stone-faced piers. The roadway was *pavé* and wide enough to take four streams of traffic, with a good footpath on either side which had a fine ornamental but solid stone balustrade. The footpaths were partly supported by a rather fancy iron archway, sprung from the stone foundations of the main piers—thus considerably adding to the above-water width of the pier that had to be tackled.

G.H.Q. B.E.F. were supposed to be at Compiègne and I had been ordered to report there, so I set off to find the E.-in-C.; however, G.H.Q. seemed to be moving—in fact, might be said to have con-

tinued their retreat—and I could find no one who could help me, so returned to the bridge. There I found Dobbie, our Adjutant, with, I think, Brig.-General Fowke, the E.-in-C.; at any rate, the latter, if not there at that moment, arrived shortly after. My mind was soon relieved about the bridge, though the proposition still remained sufficiently alarming. Firstly, Dobbie produced a French engineer



officer, complete in a faultlessly-clean white uniform. This gentleman was invaluable. I believe he was the local "Borough Surveyor" disguised as a territorial. Anyhow, he produced plans and drawings of the bridge and 1,000 kilos of melinite. The drawings and *dossier* are still in my possession.

These drawings were the key to the situation and need a little preliminary explanation. As far as I know, and it was confirmed at other bridges we met, all the French bridges in this part of the

country were built with an eye to speedy, economical and thorough demolition. Lattice girders had "boxes" to contain the right amount of explosive, constructed in the girders at the right place, etc. In the particular case of my bridge, both of the two piers had been constructed with three cylindrical iron or steel shafts built into them, covered over, of course, by the roadway, but going down some 30 feet so that their bottom was below water-level. The plans showed more or less where the roadway should be taken up to expose these shafts. The next piece of information was that Dobbie had got hold of a dump of guncotton, primers, etc., at the railway station —about a ton of it. The situation began to look a bit better now, but there was a lot of explosive to handle and my small party were desperately weary. My orders were to get the job prepared, keep the bridge open to traffic all the time, and to blow the charge at 11 a.m. next day (August 31st).

We collected the guncotton and dumped it on the footpath near by the pier selected for demolition (the pier nearest the south-east bank), using a "borrowed" civilian cart for the job. The French had already dumped the melinite against the river wall at the south-east approach to the bridge upstream. We picked up the *pavé* at the three points indicated, and after digging out a further foot or so of very hard core, exposed circular iron covers which took considerable removing before we had our three cylindrical shafts actually exposed. These proved to be some 30 feet deep and 1½ feet in diameter, and had been so spaced in the width of the roadway that it was possible to keep two trafficways open between the actual shafts. These shafts, on test, proved to be dry and the air in them, if not pleasant, was not lethal. At this juncture we were joined by a welcome reinforcement—Capt. S. F. Newcombe; where he came from, or what his job was, I don't know, but he had a speedy car which was of value later.

By now it must have been about 9 p.m., a fine, dry night and plenty of street lighting on the bridge; traffic heavy, all sorts—military and civil. Newcombe insisted on being lowered down the first shaft, while we lowered guncotton down to him in sandbags. One foot six inches is a cramped space and the only way was to cram the sandbags between the knees, let it go, and then tread it into place, so gradually raising oneself on a foundation of guncotton. Not at all a pleasant job.

Up on the surface all the G.C. boxes had to be opened and the slabs put in sandbags—we put roughly 400 lb. in each of the three shafts, so the labour of ripping open the boxes and containers was no light task. I was left with what I thought was the unenviable task of fixing up the firing connections. I didn't want any risk of failure, so triplicated the arrangements, one electrical circuit and two with safety and instantaneous fuze (the old red fuze instantaneous).

Three sandbags of G.C. were made up, one for each shaft, and secured in each were the three slabs with primers and detonators; the instantaneous fuze (in duplicate) and electric leads were tied in securely at the neck of the sandbag and the lengths of instantaneous fuze were cut to equal lengths, they and the leads had to be long enough to be brought to the top of the centre shaft (about 40 ft.) over which all joints and connections were made. *Pavé* was removed between shafts to make a narrow channel for fuze and leads, and filled in with sand and gravel so that traffic could pass over. The charges were connected electrically in series in the ordinary way—each set of three instantaneous fuzes was connected to a short length of similar fuze to which was attached about 6 ft. of safety fuze. All this sounds very prosaic, but it had to be done by tired men in the midst of the traffic, and it must have been nearer dawn than midnight before all was set.

The melinite was in packing cases which, when opened, were found to contain ½-kilo sealed tins with melinite cartridges in them—rather like sardine tins. We added about 50 kilos to each shaft, more as tamping than anything else, and then two or three sandbags of road gravel which was nearby. My party got an hour or so's rest, and soon after dawn I sent them and the tool-cart off to rejoin the Company. I loaded on to the tool-cart as much of the surplus boxed guncotton as I could, also fuze, detonators, etc.; anything left over remained on the pavement and eventually went up with the bridge. I could only give them the vaguest of directions: we had no map between us, and it is to their eternal credit that they reached the Company that day. After dawn traffic increased—all from north-west to south-east. I got a bit of a shock when a passing cavalryman threw his cigarette-end down one of the shafts! So did he, when I told him what was at the bottom—however, nothing happened. There was still another shock to come—the melinite not used had been left in a pile by the river wall; some A.S.C. lorry drivers had broken open a couple of cases and with the wood lit a fire under the lee of the remaining cases and were boiling water in their canteens! My remarks quite spoilt their meal; with their help, I had the remainder of the stuff pitched over the wall into the river. Even this drastic treatment was not to be the end of the wretched stuff as far as I was concerned.*

By 9 a.m. traffic slackened, the R.H.A. and Field Squadron R.E. passed over about this time, and then all we saw were belated

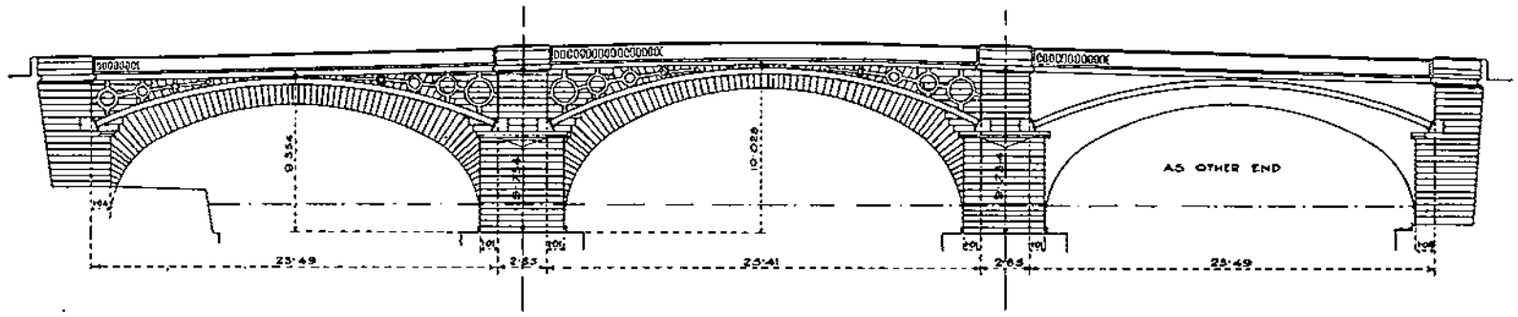
* While serving with the 60th Division in Salonica in the summer of '16, a letter reached me through the "usual channels" and which had emanated from the French authorities, asking me to state how I had disposed of this melinite! The sleuths in this case had shown amazing tenacity of purpose, and despite several setbacks and false scents had eventually tracked me down, by name, as the correct victim. The correspondence had become a good thick *dossier*. I like to hope that, like many better things, the enemy put it to the bottom of the Mediterranean—anyhow, my answer was never questioned and I heard no more.

refugees and cavalry patrols. By 10 a.m. the place was pretty well deserted, but those who did hurry over the bridge sought to cheer us by telling us how near the enemy patrols were—Uhlans.

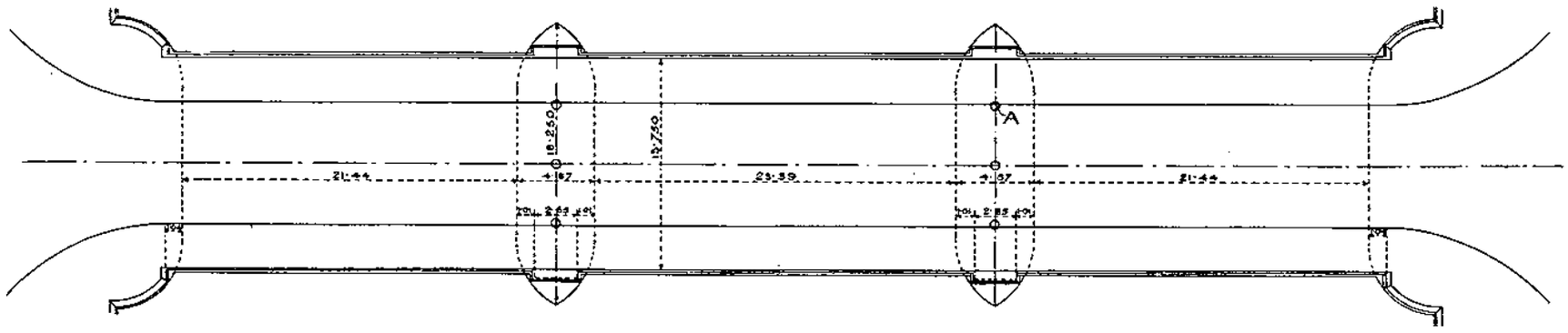
Brig.-General Fowke (E.-in-C.) had waited, and he, another Staff officer, whom I did not know, Newcombe, myself and the drivers of the two cars, were the only British uniforms present for the last half-hour or more of waiting. At 11 a.m. the E.-in-C. decided we could blow the bridge; the leads had been run out up the street off the bridge—about 200 yd.—and connected up to the exploder. We were slightly up a slope there, but could not see across to the approach to the bridge on the far bank, owing to the rather unusual amount of camber in the bridge. Exactly as I pressed down the handle of the exploder, a refugee car dashed on to the bridge—I should say it was directly over the charges at the psychological moment. I think all Sapper subalterns will appreciate my feelings at that precise second when I say that nothing happened!—just absolutely nothing, failure in truth in the very sight of the "powers that be." The lucky star of those refugees must have been navigating at a higher altitude than mine that morning. They stopped when they saw us: their faces were a study when they realized what had happened. The exploder remained inanimate. Several days later we tested the exploder and found that the brass contact plate at the base had been fractured off. To the pertinent and obvious query—why hadn't I tested it?—I can only say there was no time to do so until the charge was laid, and if I had then found a fault it would have been next to impossible to have got another exploder. On the whole, I am glad I hadn't tested it, though this is a bad moral to accept from this incident. I have always admired Brig.-General Fowke for his forbearance at this crisis; no recriminations were uttered, though goodness knows they would have been excusable. Now feeling thoroughly on edge, I had to rely on my own handiwork, the safety and instantaneous fuze—the only error here was over-celerity, the 6 ft. of safety went in about 30 sec. but detonation was very, very complete. It was perhaps fortunate that the fuze burnt so quickly, because after lighting it, and just as we had got clear of the bridge, the local village idiot dashed for the bridge and reached it just as the bridge ceased to be a bridge. Luckily for him he was not injured—he must have been either drunk or a lunatic, anyhow, we didn't stop to find out which!

Absolutely nothing remained, above water, of the pier and the two arches it supported; from the abutment at the bank to the next pier there was just nothing. There were two surprising features about this demolition; there was practically no noise and there was no tangible debris. There was a definite feeling of concussion and a big cloud of black "smoke"; when the latter subsided, there was

LE PONT DE COMPIÈGNE.



ELEVATION



PLAN

NOTE—
DEMOLITION CHAMBERS SHEWN O

SCALE—

DECIMETRES 0 10 0 10 20 30 40 METRES

F.A.S.
OCTOBER

Copied from the drawings in the Formal Ponts et Chaussees Dossier.

no bridge. I expect this can be accounted for by the fact that the charge was below water.

I cannot describe the feeling of relief with which I saw the bridge go; if it had failed, I imagine I could have written *finis* across my future career! Anyhow, I came to, so to speak, conscious that I was holding out my hand to Newcombe and feeling rather an ass. However, Newcombe was made of sterner stuff, and I don't think had any idea that I felt like shaking hands all round, and he very prosaically, seeing my outstretched hand, passed over the key of the ill-fated exploder! Thus do our great moments come to an end. As a matter of fact, we hadn't time now for anything except to get clear quick—the whole place was quite deserted. Brig.-General Fowke went off in his car and Newcombe very kindly took me and my bike (with exploder) into his car.

The Retreat—Part II.

Our retreat in the car was uneventful and I was eventually deposited in some village, where there were many troops. Where it was, I had no idea and was too weary to care—it wasn't in the 4th Division line of retreat, and no one I asked had any idea where they were. So, with that wretched bicycle and exploder attached, I set out into the blue to find my Company. In some stupid way I stumbled into the fringe of Compiègne Forest, but this proved unhealthy and I was soon assured that I was in the wrong place. After further blundering I did eventually find the Company just at dusk, going into bivouac near St. Saveur in the south-west corner of the Forest of Compiègne; but no sooner had I joined them, feeling pretty well exhausted, than the Company was ordered to move south two or three miles across the valley to the high ground above Saintines. We stumbled into a field and bivouacked late in the dark, near a farm called La Hay or La Fay. We were not to get much rest, though; heavy rifle and machine-gun fire, very soon backed up by gun-fire, roused us at dawn. The countryside was wrapped in mist and it was hard to tell what had happened. It was quite evident that the enemy had got through the outposts; in fact, one Uhlan popped his head over the hedge on one side of our bivouac and was promptly bagged by our sentry. Our transport was pushed off at once and we turned out as escort to a field battery. An unpleasant situation was restored early in the morning and the retreat was resumed. It was during this encounter that the Queen's Bays, just on our right near Nery, were so badly cut up while in bivouac and that "L" Battery R.H.A. gained for itself much renown.

We actually spent a night at Nery when going from the Aisne to the left flank in October, and were able to have a look at the ground

and reconstruct to some extent what did happen. We didn't realize how close we had been to trouble at the time and were undoubtedly saved by the mist.

When the situation had been restored, we were sent back to Rully to " put it in a state of defence " ; we got there about noon, but information and orders as to possible direction of attack were many and conflicting. Uhlans were reported as being in our rear. They were, too, and eventually our work must have faced almost in every direction ; I hope none of it proved of use to the enemy—in any case there wasn't much ; one field company can't do much by itself in four hours or so. Later, we moved on to Fresnoy, from where I was sent back to give what assistance I could to the 19th Brigade on outpost position. The 19th Brigade was the Brigade unallotted to a Division of the B.E.F. on mobilization ; originally intended for L.-of-C. they were soon in the battle-front and were, as a consequence, deficient of those other arms of the Service whose support and help a brigade of a division would have by right. I believe about this time the 4th Division and 19th Brigade formed the III Corps, but we knew nothing of Corps H.Q. and very little of our own Division H.Q. in those days. I was sent along the whole Brigade front and helped co-ordinate the line of the two Battalions—the Middlesex were on the right, I remember. I got back to find the Company had flitted, but picked them up nearby. The view in the dusk from the outpost line was fairly extensive and certainly awe-inspiring : most of the villages we had left seemed to be in flames. The next 36 hours stand out as one long laborious stretch of *pavé* to be conquered. We covered a good distance, but we were in a bigger column than previously, and the checks were just heartbreaking. We left Fresnoy at 3.30 a.m. on September 2nd, and by way of Baron Leve, arrived at Dammartin about 7 p.m. We moved on again at 11.45 p.m. and reached Lagny, on the Marne, at 9 a.m. on the 3rd ; here we halted, but the Sappers got no rest being employed on water-supply. Incidently, the French blew this bridge at Lagny over the Marne after we had crossed. Next day, the 4th, we received orders for three days' rest. Martel celebrated by having his hair cut —someone in the mounted section officiating with the horse clippers ! That rest was too good to be true, and at 5 p.m. we moved off to Magny-le-Hongre. This was almost due east and I don't know why we went off in this direction. At 3.30 a.m. on the 5th, we started on our last day's retreat—though we didn't know it—and the Company reached Chevry at 3 p.m. At 8 p.m. I was sent back with my section some four miles to join the 11th Brigade, then in outpost position. From Magny to Chevry is almost south-west—so there must have been some big change in policy at G.H.Q. to account for this move.

The next morning, September 6th, I started off at 1.30 a.m. with

the 10th Brigade, they having advanced through the 11th Brigade outpost line, as advance guard, and the advance to the Marne had started. As soon as we realized we were marching forward, we found more spring in our feet and generally felt better. It was all really quite astonishing; we could see no reason for this about-turn, but on performing the movement we all immediately felt much better in every way.

General Remarks on the Retreat.

First of all, food for man and beast; this came to us by dumps made on the line of retreat by the A.S.C.—we were never short of actual rations; the difficulty generally was the cooking and eating. No sooner had one started a bit of a fire than one had to move on. Rations were easily supplemented by "local produce," paid for if anyone had stayed behind to take the cash!—otherwise, and more often, just "acquired." Occasionally one obtained a jar of rum—and that stuff *was* rum, too; no 1918 vintage, but the real stuff, which was reputed to have been in bond since the S.A. War.

"Tummy" troubles, to a certain degree, were caused by eating too many of the apples which grew so freely along the roadside; they were not eaters and the results were unpleasant.

The reservists' feet naturally gave some trouble, but the Company finished the retreat without a man falling out; though, indeed, there was little incentive to fall out.

As regards strategy and tactics the fog of war was complete, and I don't think I am in any way exaggerating when I say that no junior regimental officer had any real idea as to what was happening. The general impression was that, for some reason, the enemy was always round our flanks, that he had far greater numbers of men and machine-guns and heavier artillery. This outflanking business always meant getting out of nasty situations; it ended abruptly on September 6th; to us, at the time, it seemed quite unexplainable. We lived without information, fed on rumour, so I don't think it is incorrect to state that the regimental officer who took part in the retreat really knew least about it all. However, it is quite easy to remedy that ignorance now from the spate of good, bad, indifferent and controversial war books on the market!

PART II.

The Marne.

The last night of the retreat, September 5th, I had spent with the 11th Brigade; the 10th Brigade, however, went through the outposts and became Advance Guard for the advance; I was ordered

to join them and marched with the Seaforths and remained with them for the 6th and 7th, reaching La Haute Maison, where I rejoined the Company. On the 8th, the 11th Brigade took the lead and the Company joined them, marching to Le Grand Glairet. At 8.30 p.m. the Company was turned out to put Jouarre in a state of defence, and we dug trenches and machine-gun posts. Jouarre was on the high ground on the south side of Marne River valley. It always seemed to me odd that we should have been kept out, digging, all that night, when it was apparent that all our energies would be wanted in the very near future to bridge the Marne.

Next day, the 9th, at 9 a.m., we moved down to La Ferté sous Jouarre to bridge the river; street fighting and sniping was still going on and we didn't get near the river till noon at the earliest. It was then still impossible to bridge and eventually infantry were ferried over to clear out machine-gun posts that still covered the only possible bridge site near the destroyed road bridge. I think the 23rd* Field Company blew one arch on the retreat. The enemy, not to be outdone, had blown the remaining arch and pier. However, we were far from idle and "collected" barrels, scantling and planking, etc., for the bridge. Barrels were collected from nearby cellars, their contents being run to waste; we found quite a lot of Bosche in this process, many dead-drunk. I am glad to say none of our men succumbed to such an easy temptation; all realized there was too much to be done.

The bridge was actually started at 5.45 p.m. The 7th Company worked on it, too; I think, generally speaking, our Company dealt with pontoons and barrel piers and the 7th Company with barges and boats and the approaches. My personal job was barrel piers —and here came in the value of the old Field Work training—everything, slings, gunwales, braces, etc., had to be improvised; yet after our first "pier," the old drill all came back, and reservists and serving soldiers were soon hard at "rock and heave"—the one as knowledgeable as the other.

The bridge length was 218 ft. and we had the two Weldon trestles (thrice-cursed things to erect, to adjust, and worse still, to withdraw) and the four pontoons of the two Companies—the rest we had to find and make. Actually, in addition to the above, the bridge was made up of five barrel piers, one large and one small barge and two rowboats; it was finished at 6.30 a.m. on the 10th, and the Division started crossing at once. The actual last link was dramatic—all we had had been put into bridge and didn't meet!—when R. G. Wright, of the 7th Company, suddenly appeared from upstream in a rowboat, which just did the trick and saved the situation. The "factor of safety" of that last bay must have been *nil*. We spent the whole of the 10th caring for that bridge, while a ceaseless stream of traffic

* See *The R.E. Journal*, June, 1932.

crossed without one single accident or hitch. The two Companies crossed in the evening.

At 4.30 a.m. on the 11th, both Companies were told to lift their bridging equipment and, broadly speaking, catch up the Division who would want the Aisne bridged—no mean task. The bridge was just cut and our gear lifted out and both Companies started forward at 8 a.m.

There is no doubt that, if a Pontoon Park could have been got up to us, the Marne—as far as we were concerned—could have been bridged in a quarter of the time. It must be realized that all the roadbearers and decking, in addition to the floating piers, had to be found—some came from the local builders' yards, not much though, the majority was just ripped out of nearby buildings; all this took a lot of time and energy.

The Aisne.

This march to catch up the Division was no light undertaking, and some comparison between the conditions at this point and on the retreat seem necessary to bring out our difficulties. During the retreat, higher formation or L.-of-C. lorries that brought up supplies and ammunition, generally speaking brought their stores up to dumps behind us, and we eventually fell back on to them; consequently we rarely saw these vehicles, and the transport, etc., with which we then competed on the road was, for the most part, only Divisional transport.

Now, on this advance, we started behind the fighting army, and worse still, behind its refilling points; consequently we had to share the road with full supply columns that overtook us and then met us when coming back empty; there were also ambulance convoys to be met, and lastly we had to push through our own Division second-line transport (Division train and D.A.C., all horsed) and then the brigaded first-line transport of the infantry brigades. These are only the major units with whom we competed for the road and odd bits of "empty" road were filled to overflowing with heterogeneous forms of transport. Everyone naturally considers he is the most important road user and there is never anyone present to decide vexed questions of priority—in any case, is it human nature to allow oneself and one's column of heavily-loaded wagons to be pushed off the *pavé* into the mud verges with which French roads are decorated, just to let some other column pass you? Answer, definitely NO. May I commend these reflections of the under-dog who has had some, to those who brightly urge at staff rides and exercises in these days of peace, that bridging equipment should be kept well to the rear and rushed up on its lorries when wanted, on what is beautifully called "Fire-engine terms"?

However, I digress; we left the Marne at 8 o'clock a.m. and made

a halt near Montigny, where Major D. M. Hoysted joined us as our new Officer Commanding. We continued our march to St. Quentin, which we only reached at 9 p.m. after many vexatious delays on the road. This day, September 11th, is particularly memorable in that a wonderful postal service made its first distribution of mails—how they managed it, I don't know, but very, very welcome those mails were.

Next day we started, in pouring rain, at 4.30 a.m., but were soon held up by a block of horse transport on a steep hill; in the end, we had to unhook some of our own weary teams and help clear the road before we ourselves could get on; we eventually reached Tigny at 9 p.m. Three-thirty a.m., the 13th, we set out again, reaching Septmonts on the plateau of the southern heights above the Aisne—this was apparently 4th Division's Headquarters, where the late Lord Rawlinson had taken over for a short time (to be succeeded by Brig.-General H. F. M. Wilson of 12th Brigade) vice our original G.O.C., General Snow, who had become a casualty on the Marne. We had considerable trouble getting the pontoons up to Septmonts —the mud had begun to give us a foretaste of what the winter of '14/'15 was to be, and our horses were pretty well done up. We went on from Septmonts at 9 a.m., making for Venizel—most of the winding road down to the river valley was in view of the enemy, and he was making spasmodic shooting at it and the village of Venizel with 5·9 howitzer stuff called then "Coal-boxes" or "Jack Johnsons." The road was thick with transport which couldn't get over the Aisne: we had to pass it all and were lucky to get to the river bank without any casualties. There were several decent-sized shell craters in the road which we had partly to fill in before we could get the pontoons along—altogether it was not a nice trek, and I, for one, was glad to reach the river and get on with a job of work.

The bridge was started at noon and finished at 5 p.m.; 190 ft. in all, three trestles, four pontoons and the remainder barrel piers made with barrels from a convenient oil depot nearby and "superstructure" from the village, the barrel-piering drill once more proving its worth. As far as we could tell, we were in sight of the enemy; in any case, the bridge proper, 50 yards upstream, was on the map; nevertheless, these bridges were never hit by the enemy, though he was quite sufficiently persistent in his attempts to hit them.

The existing road bridge was a single-span, open lattice-work girder bridge, four charges had been placed on the top and bottom flanges of both girders respectively, one had proved a failure and the bridge remained *in situ*, obviously weakened and held up by the bottom flange of one girder and the rigidity of the roadway only. Martel was quickly after this and removed the "dud" charge, jammed some large stones into the voids caused by the explosions,

propped a handy steel-work telegraph pole under the worst flange, added a few Heath Robinson iron flats and bolts, and pronounced the bridge safe for traffic. An article on this, by Martel, appeared in *The R.E. Journal* for December, 1914, page 348.

The Sappers manhandled a field-gun over to prove his contention, and so the bridge was "passed fit for light duty only."

VENIZEL.

I am not absolutely certain as to when the 7th Company parted company from us, probably the bridge was mutually constructed; in any case we were left behind to maintain the bridge, while the 7th went on to join the right-hand Brigade of the Division (I think 12th Brigade). Little did we think then that we should remain on the Aisne and that the advance was finished—in fact, trench warfare had commenced.

My section remained on night duty on the bridge; in the early morning an 18-pounder complete drove over the side of the bridge, three horses were lost and the gun remained at the bottom of the river for three or four days before we could get it out. Considerable damage was done to the bridge and it took two hours to get it repaired. In fact, soon after, we made up some spare barrel-piers for such emergencies. During September 14th the Bridging Train arrived, and with its stores we built another "all-pontoon" bridge at night, about half a mile upstream—this only took about 2½ hours and looked an amazingly tidy bridge compared to our previous improvisations. Having completed the job we returned to the village to find our O.C. had secured "billets" for the Company—it seemed an unheard-of luxury, and that night some of us got our clothes off for the first time since we left Rouen.

The Company retained these billets as their H.Q. all the time we were on the Aisne.

The 15th was an unpleasant, wet day; despite all we did to the approaches to the bridge and the decking of the bridge itself, the former were unpleasantly steep and the latter uncommonly slippery—in fact, passage became so awkward that we found it best ourselves to lead the animals in the lead of any team. A handrail and screens had by now been added to the bridge. The climax came about midnight when I was leading over a six-mule team drawing a French ammunition limber. The French drivers had no idea of any speed other than fast, and all might have gone well if the centre lead had not suddenly dug their toes in—the wheelers edged over to the offside and the limber ran over. It was a very extraordinary feeling as the bridge gradually sank, the decking opened out and through and down we went. Fortunately, the front and rear halves of the limber fell on either side of a barrel-pier, which kept them up to some

extent, and we were able to get the whole lot ashore with no damage, except to the bridge.

It took four hours' work to get the bridge open for traffic again, repairs being mostly effected with pontoons and equipment from the Train.

About this time we realized that rain and trench warfare had set in for better or for worse, and we had to set about reorienting our ideas on war.

TRENCH WARFARE ON THE AISNE.

On, I think, September 17th, two sections went forward to the 11th Brigade on the left, the 7th Company working with the other two Brigades. The remainder of the 9th Company remained at Venizel (though change-rounds of individual sections took place when possible) working principally on :—

(1) and most important, the Aisne bridges.
(2) Defensive positions on south heights overlooking the Aisne, with civilian gangs or *équipes*.
(3) Collection of material, *i.e.*, R.E. stores for the front line.
(4) Protection for R.A. batteries.

Two events marked this period : firstly, money was obtained to let the men have their first " pay parade," and secondly, blankets were obtained and issued—I think, only one each.

THE AISNE BRIDGES.

We now held three bridges over the Aisne.

Bridge A.—Our original floating bridge just downstream of the bridge proper.

Bridge B.—The bridge proper, now partially repaired and on light duty.

Bridge C.—The pontoon bridge, about half a mile upstream of Venizel.

With stalemate in the front line, Brigades began to get nervous about their communications and more and more bridges were asked for and were made.

Bridge D.—A light barrel pier bridge for infantry in single file, two miles downstream—about 176 ft. long—constructed September 17th.

The continued rain now began to be really felt, in that it was obvious that the river was going to rise—to what extent it would flood, we didn't know, but we had to be prepared. More piers were made up (barrels) and some barges were collected : enough were towed down to near Bridge D in case they were wanted. As they

had to go through our original Bridge A, the opportunity was taken to overhaul the latter and, to our relief, remove the Weldon trestles and substitute barrel piers. I am sure we were all glad to see those miserable trestles back on their wagons.

On the 20th, the "infantry in single-file" Bridge D had to be widened for infantry in file, and the next day it had to be moved 100 yards or so on account of the floods; in fact, all our floating bridges now required lengthening to meet the rise of the river, and this operation was carried out also on the 21st.

Bridge E was built on September 25th, and was between A and D, behind the 11th Brigade—it merely consisted of the barges previously towed down, connected up by a series of gangplanks and would only take infantry.

Bridge F.—On the 27th, Martel and his section went to Soissons, on the boundary of the English and French Armies. There he remained until we left the Aisne, building a semi-permanent wooden box-girder road bridge, which was the original "Martel Box-girder Bridge" (see *R.E. Journal*, December, 1914, page 345). Incidentally, he "borrowed" some of the best tradesmen out of the other sections to help!

Bridge G.—Another "barge bridge," near Venizel, on September 29th.

Bridge H, and lastly, a third barge bridge upstream and behind the Division's right flank.

Until October 6th, when we left the Aisne, all these bridges had to be maintained and constantly adjusted to the rise and fall of the river level. They were shelled in irregular "hates," but never hit so as to be put out of action; the enemy even tried aeroplane shoots at the Venizel bridge but was no more successful. To counter this latter pastime the first A.A. unit I saw appeared on the scene—apparently a S.A. War 1-lb. pom-pom on a special mounting; quite spectacular, but futile.

Trench Warfare.

At that time we could give the infantry little help other than advice; tools and stores were non-existent. Nevertheless, a great deal was done. Barbed wire was ripped up, coiled, taken up to the line and there put up by us as a crude single fence with wooden posts. Spades of the local variety were collected and given to the infantry, and some splinter-proof shelters were "knocked up" with doors and window shutters. Water supply was improved and observation posts constructed. In fact, one hundred and one small domestic aids were carried out, but with the numbers available it was only a drop in the ocean.

Beyond the fact that this period marked our initiation into the unpleasant task of wiring in front of our own infantry, I do not

propose to go into the mysteries and miseries of trench warfare any further—the enemy were already ahead of us in this type of warfare and annoyed our wiring parties with a small searchlight; flares or Very lights, etc., were as yet unknown, though again in this latter respect, we were a bad second when the enemy first exploited them in Flanders.

WORK WITH THE GUNNERS.

This consisted in the main, excepting water supply at some horse lines, in helping to construct cut-and-cover splinter-proofs for personnel and ammunition. One personal instance will suffice to illustrate the work.

On September 25th, after helping complete Barge Bridge E, my section got back to Venizel and was sent straight off to find the 31st Heavy Battery R.G.A. (60-pounders) and help dig them in. They were on the southern heights above Soissons on the extreme Division left flank, where, I understand, they had been asked for, to assist the French against some particular target. We reached them at 8 p.m., just as they were getting the guns into position. However, we had done very little work before some excited French officers appeared. Apparently we were just above and behind some high French H.Q. and they objected strongly, and naturally, to such a happening. Several hours were wasted before a decision was arrived at and the battery eventually moved to a spot that the French suggested as an "eligible site." The guns were, of course, horse-drawn: eight magnificent heavy draught to a team. It was nearly 4 a.m. before we started work; the battery got into action at dawn before our side of the work was complete. Evidently they proved pretty annoying, because very soon an enemy aeroplane appeared overhead, dropping coloured lights, and we felt that trouble was brewing. As soon as it had become light, we had all seen rather too many shell-holes in the vicinity and it transpired later that a French battery had found the climate at this spot uncongenial! I took the precaution of hooking in my tool-cart and preparing it for speedy evacuation from its position in a sunken road behind the battery position. The enemy's first effort was short, his second well over: that seemed a good moment for the tool-cart to go—a lucky decision, because when the enemy shortened his bracket, his next lot of overs arrived just about where my tool-cart had been.

Colonel Franks (commanding the Battery) eventually withdrew his men and mine to a flank, and so the casualties were not very many. The enemy put up good shooting and landed one shell between a gun and its limber, knocking in a half-finished splinter-proof and doing a little damage to the gun mounting. As soon as the hate was over, fire was reopened but the Battery had eventually to move—whether before its particular mission had been accom-

plished or not, I don't know—anyhow I was sent away, having done very little of any use.

Three days later, I helped another 60-pounder battery (105, I think) on the right or opposite flank of the Division. I don't know what formation they belonged to; they certainly were not 4th Division.

Preparations for a Move.

On October 5th, we started to prepare for the move round to the Coastal Sector—everything had to be kept very secret and moves done by night. Our bridging equipment in use, in our original Bridge A, was replaced by barrels and everything got ready to clear our own and Bridging Train equipment in Bridge C.

We had been on the Aisne now for three weeks and had got pretty used to the place. It was very astonishing how soon one got to learn what a methodical fellow the enemy was, and we all soon found out that certain spots were accorded a regular "hate" at prescribed times. The acquisition of this sort of local knowledge soon became a natural trait and a very invaluable one, too.

During this period, too, we had received a certain amount of odd stores and boots and clothing, which were made very welcome—some of the men's boots were in a deplorable condition before replacements became available.

Our official "1st Reinforcement" reached us, too, during this time—one Corporal and ten men, I think, though this was not enough. This "1st Reinforcement" consisted of an authorized number of men who mobilized with the Company, went overseas with it, and were then left at the base on landing overseas.

We went through a real spasm of spy fever at this time—they were mostly supposed to travel in cars, often disguised as hospital nurses, but generally as Staff officers. Certain distinguished R.E. officers, who used cars on their lawful occasions, sometimes became suspect as spies and will probably remember this period and a similar one in the early days in Flanders; wandering in cars behind the French area led to difficulties at times, which sometimes necessitated the presence of the humble subaltern to bail them out, when they had become the victims of excessive French zeal.

(To be continued.)

APPENDIX "A."

4TH DIVISION.

ORDER OF BATTLE, 1914.

Commander	...	Maj.-Gen. T. D'O. Snow, C.B.
G.S.O. 1	...	Col. J. E. Edmonds, C.B. (now Official Historian).
G.S.O. 2	...	Lt.-Col. A. A. Montgomery, R.A. (now C.I.G.S.).
G.S.O. 3	...	Capt. E. T. Humphries, Lancs Fus. (now G.O.C. 5th Division).
A.A. and Q.M.G.	...	Col. F. P. S. Taylor.
D.A.A. and Q.M.G.	...	Capt. B. F. Burnett-Hitchcock, Sherwood Foresters (now Lieut.-General).
D.A.Q.M.G.	...	Capt. H. J. Elles, R.E. (lately D.M.T., War Office).
C.R.A.	...	Brig.-Gen. G. F. Milne, C.B., D.S.O. (lately C.I.G.S.).
C.R.E.	...	Lt.-Col. H. B. Jones, R.E.
Adjutant R.E.	...	Capt. W. G. S. Dobbie, R.E. (now Comdt. S.M.E.).

10th Inf. Brigade	...	Brig.-Gen. J. A. L. Haldane, C.B., D.S.O.
Brigade Major	...	Major A. H. H. Wilson, Wilts Regt.
11th Inf. Brigade	...	Brig.-Gen. A. G. Hunter-Weston, C.B., D.S.O.
Brigade Major	...	Capt. G. F. Boyd, D.S.O., Leinster Regt.
12th Inf. Brigade	...	Brig.-Gen. H. F. M. Wilson, C.B.
Brigade Major	...	Capt. C. M. Davies, Rifle Brigade.

7th Field Company R.E.:	*9th Field Company R.E.:*
Major S. G. Faber.	Major J. B. Barstow.
Capt. V. P. Smith.	Capt. G. F. Evans.
Lieut. R. G. Wright.	Capt. F. C. Westland.
Lieut. G. N. Macready.	Lieut. G. Le Q. Martel.
Lieut. K. I. Gourlay.	Lieut. C. E. Fishbourne.
Lieut. W. D. Stavert.	Lieut. B. K. Young.

4th Signal Company R.E.	...	Bt. Major R. S. McClintock, R.E. Lieut. V. A. C. Clery, R.E., and 3 Infantry officers with the Brigade Sections.

APPENDIX "B."

Message from The King.

"*Buckingham Palace.*

"You are leaving home to fight for the safety and honour of my Empire.

"Belgium, whose country we are pledged to defend, has been attacked and France is about to be invaded by the same powerful foe.

"I have implicit confidence in you my Soldiers. Duty is your watch-word, and I know your duty will be nobly done.

"I shall follow your every movement with deepest interest and mark with eager satisfaction your daily progress; indeed your welfare will never be absent from my thoughts.

"I pray God bless you and guard you and bring you back victorious.

"George, R.I.

"*9th August*, 1914."

APPENDIX "C."

"You are ordered abroad as a soldier of the King to help our French comrades against the invasion of a common Enemy. You have to perform a task which will need your courage, your energy, your patience. Remember that the honour of the British Army depends on your individual conduct. It will be your duty not only to set an example of discipline and perfect steadiness under fire, but also to maintain the most friendly relations with those whom you are helping in this struggle. The operations in which you are engaged will, for the most part, take place in a friendly country, and you can do your own country no better service than in showing yourself in France and Belgium in the true character of a British soldier.

"Be invariably courteous, considerate and kind. Never do anything likely to injure or destroy property, and always look upon looting as a disgraceful act. You are sure to meet with a welcome and to be trusted; your conduct must justify that welcome and that trust. Your duty cannot be done unless your health is sound. So keep constantly on your guard against any excesses. In this new experience you may find temptations both in wine and women. You must entirely resist both temptations, and, while treating all women with perfect courtesy, you should avoid any intimacy.

"Do your duty bravely.

"Fear God.

"Honour the King.

"Kitchener,

"*Field-Marshal.*"

THE TEMPORARY ROADS DEPARTMENT—II.

By "ROADSURVEY."

"We Discuss Some Road Survey Problems."

A PREVIOUS article (*The R.E. Journal*, September, 1933) gave some details of the personnel and work of the T.R.D. This department, which was run entirely by Sapper officers and N.C.O's, had the job of surveying and constructing roads on the Gold Coast. It started from nothing; no one knew exactly what sort of road was required, and, more especially, how anybody set about surveying for a road through tropical country.

Many of the problems took a considerable time to solve, but space will not permit of a lengthy description of all the difficulties encountered. The following conversation and correspondence is entirely fictitious, but serves to show, in a very condensed form, the type of difficulty that was met, and the way in which some of these difficulties were solved. The characters are imaginary, and no claims for libel can be entertained.

Three officers were seated on the veranda of a dilapidated bungalow. It was very hot. The senior member of the party, who had been reading the *Manual of Military Engineering*, Vol. V (Roads), closed it with a sigh and looked up. The other two were asleep; but his aim was accurate. They woke up and addressed their C.O. in terms ill-befitting their very low position on the subalterns' list.

"That ****** book does not seem to help much," said the C.O. "I am still completely in the dark as to what standard we should aim for. Let us first of all make a list of what we consider to be the essentials of a good road."

After some argument, the assembled company were able to agree that a good road must embody the following points:—

(*a*) Low cost; (*b*) minimum length; (*c*) easy grades; (*d*) easy curves; (*e*) adequate width; and (*f*) good drainage.

"That is something to start on, anyway," said the C.O., mopping his brow. "For the moment, let us leave items (*a*), (*b*) and (*f*) and tackle the other three. What in the deuce is an easy grade? Chuck me that *M.E.* vol. Now, listen carefully.

> "'In Great Britain there is no fixed limit, but gradients should not be steeper than 1 in 20: Telford adopted 1 in 30 as a general rule. In France and India the ruling gradient is 1 in 20, while in America 1 in 11 is not considered too steep.'"

"In Jamaica, however, where the native carelessly casts his banana skin upon the highway, the maximum grade—Well, that is the best place for it," said the junior of the three, as the *Road Manual* flew past his head and disappeared over the edge of the veranda. "What we want to do is to consider first of all the lorry that will use the road. Let us wash out the horse, *pro tem.*, because a road designed to take motors will be all right for animals."

"I don't agree," interrupted the other subaltern.

"What matter! There are no horses in the Gold Coast, anyway. Now most of the produce of this God-forsaken country," continued the junior subaltern, "is taken along the roads, such as they are, in pneumatic-tyred lorries, up to about 5 tons capacity. These lorries are driven by natives, who go like hell and play havoc with their gears every time they try to change down. Therefore it seems to me that the more we can cut down the necessity for gear-changing, the longer the life of the lorries and so the more efficient the road from the point of view of cheap transportation."

"Pretty obvious, but the child's remarks show signs of common sense," said the C.O.

"I am reluctantly compelled to agree with you," said the other subaltern, who seldom agreed with anybody. "I should imagine that a lorry like those used here would go, fully loaded, up a gradient of about 1 in 20 in third gear (I am assuming that most lorries have four forward gears), and if it has been travelling along level ground it should be able to climb 300 yards of about 1 in 16 or 100 yards of 1 in 14, using the same gear. What do you think?"

"That sounds reasonable to me."

"Then what about laying down, as our first principle for the grading of the road, that we will allow a ruling gradient of 1 in 14. We cannot build a racing-track so that only top gear has to be used, and the native driver can at least get into third gear more easily than into second or first."

"But we shall have to use some gradients less than 1 in 14," put in the junior member, "for otherwise the road will be so expensive to construct that the Government will simply chuck up the idea of making it, and incidentally chuck us out, too."

"Yes," replied the other subaltern, "we shall have to use an occasional gradient which necessitates the use of second or first gear, but I suggest that our principle be to use such grades as seldom as possible, and only when they will give a considerable saving in the initial cost of the road."

"This is definitely one of your brighter days," said the C.O.; "we are undoubtedly making progress. But we must not forget that the cost of maintaining the road, as well as the cost of constructing it, must be taken into consideration. While you fellows were snoring your heads off last night, I had a look at this American book

on *Road Engineering*. It lays down that the maximum permissible gradient for a gravel surface, such as we shall have to use, is 1 in 10. The writer is probably perfectly correct, but to be on the safe side, let us say that the maximum that we will use will be 1 in 11. In the case of tarred roads, he gives a figure of 1 in 12½. We had better remember that, in case we are suddenly told to make one. Now keep quiet a bit while I write out the results to date."

The atmosphere got more and more like that of a greenhouse. The two subalterns were asleep again when the C.O. next spoke.

"What about the following rules for the grading of the road :—

(1) Where the surface is made of gravel, the maximum gradient should be 1 in 14, but occasional stretches, not more than 400 yards long and not more than 1 in 11, may be used, provided that such stretches are preceded by at least 100 yards of straight level, or down grade.

(2) When there is the possibility that the road surface will be of a tarred nature, the maximum gradient should be 1 in 14, but occasional short stretches, as detailed above, of not more than 1 in 12½ may be used.

(3) No gradient of 1 in 16 on any road should be continuous for more than half a mile. and no gradient of 1 in 20 should be continuous for more than one mile. The intermediate stretches between such continuous gradients should be of not more than 1 in 25 and at least 200 yards in length.

"The rules under number (3) are to prevent the native drivers going full out on third gear for a long time until their engines get red hot and die on them."

"Those appear to be excellent," agreed the other two.

"I remember reading somewhere," continued the C.O., "that the average gradient was important. Apparently the average gradient is the total rise and fall in feet divided by the number of hundreds of feet (linear) over which that rise and fall takes place."

"S'truth!"

"For example, if the total rise and fall over ten miles(53,000 feet) is 2,500 feet, the average gradient over those ten miles is 2,500 over 530, or 4·7% (about 1 in 22). That would be a distinctly hilly road, I imagine, and barely within the rules for maximum gradients which we have just laid down. In that case, to my mind, a better location line would be one taken over a greater distance, with slightly more curvature but with an easier grade.

"The average gradient must, of course, depend on the country. I suggest that for all ordinary undulating country, over lengths of ten miles, we try to keep below a figure of 1 in 40 or about 2·5%."

"There is one thing more while we are on gradients," said the senior subaltern. "What about the minimum grade in a cutting.

If there is no grade at all, the water will soon fill the side drains and flow over the road."

"That is true. I should think that for an ordinary unlined drain, the minimum slope should be about 1 in 100. We will lay that down to start with, anyway."

"Well, there is another hour before lunch," continued the C.O., "so we had better tackle this question of the curves. (Groans from the other two.) It should not take very long, because I have already worked out one or two ideas."

"Strange to say, so have I," interrupted the junior subaltern. "The other day I was reading some stuff on the subject, and the writer stated that the employment of superior curves (whatever those are!) for transition between the straight line and the circle, would bring about an economy both in construction and in maintenance of considerable value. I do not agree with the fellow.

"Imagine a native lorry going along the road full out. Painted on the side we see 'Maximum load 2 tons.' He has on board two tons of cocoa, three mammies, ten children, fifteen utensils (various) and a case of gin. He sees the road beginning to curve and that he should, with luck, be able to get round it. He does not slow down, therefore, until he suddenly finds the rate of curvature increasing and that he must slow down or 'go for bush.' He treads on everything. Result—road and tyres torn to pieces, one mammy and three children damaged and total loss of one case of gin.

"In the case of a simple curve, however, the driver sees the road curving in front of him. Supposing that he can negotiate the bend he sees at the speed at which he is travelling, there will be no necessity for him to reduce his speed at any point on that curve. His limit of vision will always be the same (considering curvature only), so that no given point will be more dangerous than any other.

"You know what these native drivers are! They will not slow up for anything if they can possibly help it. Therefore, I suggest that we always use a simple curve for changing direction, and that we make them as easy as possible."

There was a pause in the conversation. The last speaker and the C.O. gazed with pained surprise at the somnolent figure between them.

"'Tis amazing how much that man can sleep. Still, let him alone. It will save a lot of argument. What do you think of the last idea?"

"I agree absolutely. In any case, a simple curve is much easier to set out on the ground, especially in the bush. The next thing we must do is to decide on the sharpest curve that we can use. I discovered rather an interesting thing last night, and that is that the width of a road must be greater round a sharp curve than on the straight."

"Oh! how do you make that out?"

"Have a look at this!

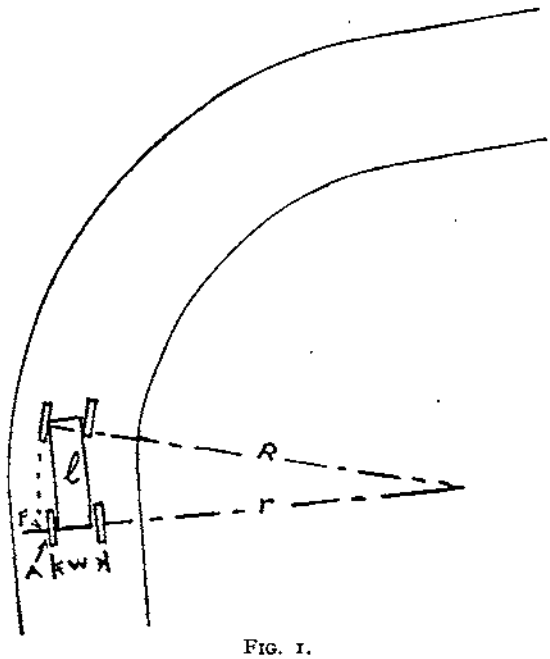


FIG. 1.

"Suppose that we take 20 feet as our standard width for two lines of traffic on the straight. In this figure here,

let R = the radius to the outer front wheel.

r = the radius of the curve traversed by the inner rear wheel.

l = the wheel base of the vehicle.

w = the width between the rear wheels.

Now if the arc of radius R is made to cut the line passing through the rear axle in point F, then FA represents the extra width required in turning.

$$\text{Then } R - (r+w) = FA \text{ ; but } (r+w) = \sqrt{R^2 - l^2}$$

$$\text{so } FA = R - \sqrt{R^2 - l^2}.$$

"This value must be doubled to allow for two vehicles passing. The table on the opposite page gives the actual extra width required for various curves, and also what I consider to be the safe extra width which should be used in practice. I have taken the wheel base (l) as 16 feet.

"Personally, I am all against having to increase the width of a road round a curve. It will be much more trouble to set out and more expensive to construct and maintain."

"Agreed."

"Let us assume that the overall width of a loaded lorry is 6 feet, the minimum safe distance apart when passing as 2 feet, and an allowance of 18 inches as a minimum distance from the outer or inner edge of the road. Then the minimum width required by two lorries passing on the straight is 17 feet. If our road is to be only 20 feet wide, then the minimum radius of the curve on which they can pass with reasonable safety is 150 feet."

"That is a very sharp curve."

Radius of Curve.	*Actual Extra Width.*	*Suggested Extra Width.*
50 feet	5 feet	8 feet
75 ,,	3·3 ,,	6 ,,
100 ,,	2·6 ,,	5 ,,
125 ,,	2·0 ,,	4 ,,
150 ,,	1·6 ,,	3 ,,
200 ,,	1·0 ,,	2 ,,

"Yes, but don't go so fast. There are some other things to be considered. What about super-elevation?"

"For goodness' sake let us have some on every curve. The lack of it probably causes more accidents than anything else. But I have not the faintest idea how much to put on. One book I read gave 1 in 10, but with a gravel surface I should imagine the maintenance charges would be enormous, and, in the case of a tarred surface, the slow-moving vehicle would tend to skid into the inside drain, especially when the brakes were applied. The camber alone is sufficient to do this in the case of the London buses."

"True. I have tried to work out something with the aid of these drawings, but the result is not very satisfactory. My dynamics are distinctly rusty, so you had better check my figures."

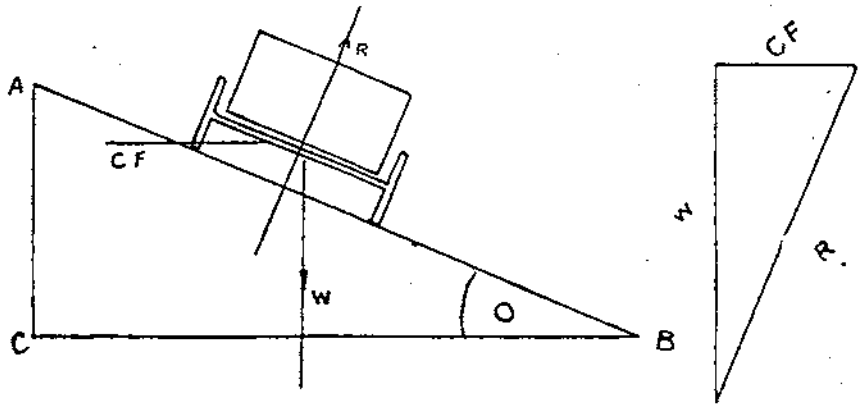


FIG. 2.

"If W = wt. in lb. of the vehicle, and R the radius of the curve (in feet), then the centrifugal force $CF = \frac{Wv^2}{gR}$, where v = the velocity in feet per second, and $g = 32$ feet per second^2. Considering the triangles ABC and $W - R - CF$ (triangle of forces)

$$\frac{CF}{W} = \frac{AC}{CB}.$$

Therefore $$AC = \frac{Wv^2}{gR} \times \frac{CB}{W} = \frac{CB \times v^2}{gR}.$$

"If we substitute unity for CB and 32 for g, the super-elevation per foot width of road is $(AC) = \frac{v^2}{32R}$ (approx.).

"Assume a speed of 30 m.p.h. and a curve of radius 150 feet, the value for AC will be 0·4, or in the case of a 20-foot roadway, the outside edge must be raised 8 feet above the level of the inside edge. But that strikes me as being far much too much for slow-moving traffic, and the action of water on such a steep side-slope would soon ruin a gravel surface."

"Your calculations look nice, but the result is certainly rather unsatisfactory. Friction must come into it somehow."

"It does. We will consider that in a moment. Do you agree to taking 1 in 20 as a good all-round figure for the super-elevation?"

"Certainly."

"Now the question of the frictional resistance between the tyre and the road (u). The book gave a value for u varying between ·08 and ·25, this value depending on the type and state of the road surface. Assuming value of ·15 for u, and a super-elevation of 1 in 20, I worked out the following safe speeds for rounding the various curves given here:—

Radius of Curve.	150 *feet.*	200 *feet.*	300 *feet.*
Speed.	22 m.p.h.	25	30

I think that we should assume that the native lorry driver will always go at least 30 m.p.h. if he can, so that means that we should not use curves of radius less than 300 feet except when absolutely necessary. What about tabulating our results now?"

"Wait a minute! There is one other thing that I have done a little work on."

"Really! You surprise me!"

"The question of range of vision must be connected with curves. Assume that two lorries were approaching each other at 30 m.p.h. The time required by the two drivers to apply their brakes and pull up to avoid each other (provided that the road is

not unduly greasy) I took to be between 3 and 4 seconds. Supposing that they had continued at their original speeds for this space of time they would (together) have covered a distance of about 270 feet."

"Yes."

"Look at this diagram.

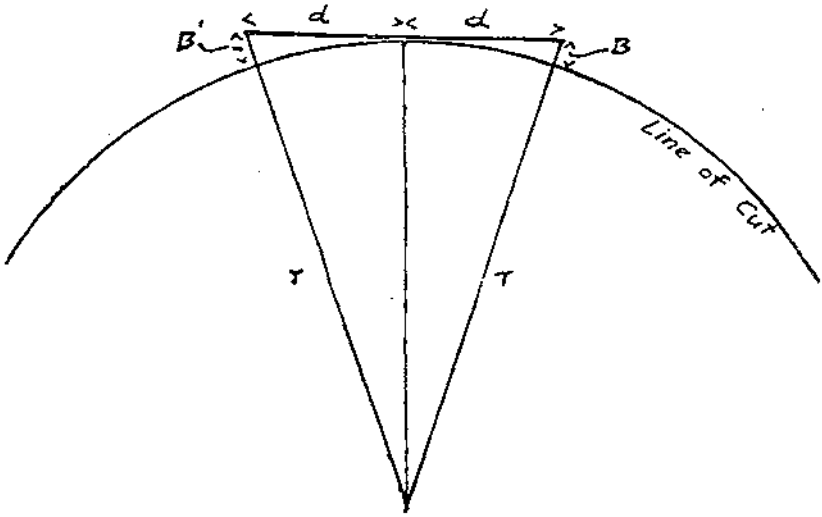


FIG. 3.

"r is the radius of the curve in feet, and d the distance of vision, also in feet. Imagine that the curve is in a cutting, so that there is no possibility of seeing anything across the inside edge of the curve. A driver's eyes, supposing that he is rounding the curve on the inside, may be taken as being about 13 feet outside the edge of the cutting. This allows 2 ft. 6 in. for the width of the drain, 6 in. for the slope back of the bank, and assumes that the off-wheels of the vehicle are on the centre line of the road. The distance at which he can see an object coming in the opposite direction and equidistant from the edge of the cutting, will be such that

$$d^2 = ((r+13)^2 - r^2).$$

Let $r = 600$ feet.

Then $2d = 2 \times 126 = 252$ feet (approx.).

"If the approaching vehicle is more on its right side of the road, which it should be, especially if the curve is super-elevated, the driver will be able to see it when it is about 300 feet away.

"So you make out that the sharpest curve that we should use, when possible, is one with a 600-foot radius?"

"Yes, that is right."

"Good. I entirely agree. Can you think of any other points?"

"No."

"Then I will tabulate our results to date."

"What do you think of this?" asked the C.O. when he had finished. "The following are the principles for the use of curves on a road of a width of 20 feet between the side drains:—

(1) All curves should be simple curves.
(2) Whenever possible, curves of a radius less than 600 feet should not be used.
(3) That any curve of radius 400 feet or less should have warning signs erected, and that no curves of radius less than 300 feet should normally be used.
(4) That in very hilly or mountainous districts where sharp curves are unavoidable, these should never be less than 50 feet in radius, and that in all cases where the radius is less than 150 feet, the width of the roadway should be increased by the amounts shown (that refers to that Table I showed you)
(5) That curves of a radius more than 1,500 feet and more than 1,000 feet in length should not be used, as the amount of super-elevation to be maintained is very great, and such construction is not economical."

"Excellent," said the junior subaltern.

"There are probably many other points," continued the C.O., "but I think that is all those connected with construction that we need consider before setting out on a preliminary reconnaissance. We had better discuss how to set about that job this afternoon. Wake up that lazy hound, and let us have some chop."

* * * * *

"You had better keep awake this time," said the C.O., addressing the senior subaltern, "because you will have to go and do this reconnaissance. The Government have given us the two places that they want connected up, and have asked for an estimate of the cost. We decided this morning the maximum gradient we would use, also the sharpest curve and the width of the roadway. The only map that is available is this one here, done to a scale of 1/62,500, with V.I. at 50 feet. From my experience, a good deal of the detail will have been 'blocked in,' that is, not visited or observed by the surveyor, but filled in so as to agree with the details obtained on the surrounding traverses and from the surveyor's knowledge of the general lie of the ground. Therefore the first thing to remember is that all the country over which you think that the road will go must be visited, to make quite certain that there are not some impossible snags, like a great number of unmarked gullies."

"Shall I have to walk all the time?"

"Yes, and hack your way through virgin bush, too. Now have

a look at this map. Here are the two places which we have got to join up with a road. The intervening country looks pretty grim."

"There is a colossal number of streams."

"We want to avoid crossing those as far as possible. It looks as if you would generally be faced with three possibilities :—

(1) To follow the bottom of a valley. This will probably necessitate the use of extensive banking in swampy ground, and many bridges or culverts to take the tributaries of the main stream.

(2) To run along a ridge. If the ground is very broken and the profile of the ridge saw-toothed, you may find this impossible.

(3) To go along the side of the slope. This may lead to excessive side-long earthworks which are very liable to subsidence, and to difficulties in draining the uphill side of the road."

"How did you pass your 'f'?" interrupted the junior subaltern. "Did not the little S.M.E. pamphlet tell you that to write down various alternatives merely to knock them on the head like ninepins was a pure waste of time?"

"Shut up! Those are the only three possibilities in most cases. What are the points to be considered when making a choice?"

"This morning we said something about minimum length," said the senior subaltern.

"Good, I will write that down as point number one."

"After that, you fell asleep," said the junior member, "so we cannot expect any more words of wisdom from you."

"What about avoiding the rivers and streams?" went on the other subaltern, ignoring the interruption.

"Point number two," said the C.O.

"I seem to remember hearing about some things called saddles; in connection with hills, not horses."

"Point number three. Anything else?"

"Gravel! If the road is to be surfaced with it, the closer we can stick to the gravel deposits the better."

"A good idea! You keep thinking while I write down what we have done so far."

It was some time before the C.O. spoke again.

"Listen to this," he said, laying down his pen. "The following points should be borne in mind when deciding on the location line for a road—

(*a*) Directness is of great importance, but the addition of a mile or two to the minimum length may be fully justified by cheaper and quicker construction, cheaper maintenance and easier transportation.

(*b*) The number of rivers and streams to be crossed should be cut down to a minimum. This cannot be too strongly emphasized. The bridges and culverts with their approach earthworks may actually cost more, and take longer to construct, than all the other work on the road. Therefore, whenever possible, leave the valleys and get on to the ridges. The extra earthworks entailed in keeping under the maximum gradient and the extra curves necessary to take the road up to, and down from, the ridge will often be amply compensated for by the few culverts necessary and the long length of the straight on the ridge-way.

(*c*) When crossing watersheds, the saddles should be marked and the various approach routes examined.

(*d*) Gravel is needed for construction and maintenance. So, whenever possible, the line should be taken through or near gravel deposits, which are most likely to be found on the high ground. During rainy weather, a hill with a good surface will be infinitely preferable to a straight level section in a river valley, where gravel is not easily obtainable and the road surface rapidly deteriorates."

"You ought to be an author, not a Sapper, such an easy flowing style, such a command of words, such—— "

"Stop burbling and come and help me mark the most likely-looking lines for the road on this map."

* * * * *

"That seems to be about all that we can do before the actual reconnaissance on the ground. When you go out to do it, don't waste time crashing about over lines that are not marked on the map, unless you find that the topographical details are very inaccurate. You will only be wasting time and energy. Always take a guide with you. He will generally be able to give you a lot of valuable information, especially about the stream flood-levels, and he will be able to lead you home when you lose yourself.

"There is one thing more that I can think of. In some places there are no paths or hunters' trails shown where we have marked a possible line on the map. In such cases, you will have to cut a line by using bearings taken off the map. When cutting these lines, I suggest that you keep the following points in mind :—

(*a*) Stick to the line! Do not try to keep to the contours by going round every bump that you meet. You will only waste an enormous amount of time and obtain a very inaccurate idea of the general lie of the country.

(*b*) Always take a guide.

(*c*) Streams likely to require a bridge or large culvert should be examined for some 1,500 feet on each side of the line, to find out whether a possible crossing with rock foundations exists in the vicinity. This is most important, because rock foundations may halve the total cost of the bridge."

"What about pace and sound traverses?" asked the junior subaltern.

"They might be useful, but I doubt it," answered the C.O. "I should not worry about them on this preliminary reconnaissance, anyway."

"What about some tea?" said the junior subaltern, getting up. "It is four o'clock already."

"All right. Get that miserable boy of yours to make some while we change for some tennis."

Ten days later.

Letter from senior subaltern to headquarters:—

Ponkikrum.
November 5th, 19—.

"Now I know why you idle stiffs sent *me* out on this job! Out of the 80 miles between the starting point and this vile spot, I must have waded for at least 20, not to mention a couple of nice swims I had, due to a mistaken idea that I could take soundings by leaning over the side of a native canoe. Can anyone tell me why we insist on reconnoitring the 'Outposts of Empire' in the tropics in the rainy season?

"Having reached roadhead, I can now sit down in peace and comfort in the Rest House here and give some account of my doings.

"There were no great snags in the first 20 miles. Thinking that there might possibly be something in what you said about getting on to the top of the ridges in preference to keeping down in the valleys, I toiled up on to the first one I came to. Do you know—you were right! The line up is a bit tricky, but by no means impossible. There is a grand run all along the top; a good two-mile straight, I should think, and an easy run down. This route will save us many culverts, and gravel lies ready to hand.

"The River Soupi—the first one I fell into—is a much bigger obstacle than it looks on the 1-in. Topo sheet. I think that the basin of this river has been underestimated and wrongly marked. It will require a 60-ft. span at least, and I suggest two 30-footers because I have found a nice crossing with rock foundations on at least one bank. The local chief informs me that rocks stick out all

over the bed in the dry season, so we should find excellent foundations for both abutments and the centre pier.

"There is another small point about this river. The local chief runs a canoe ferry about a quarter of a mile from my bridge site, and makes a healthy income out of the tolls. I don't know if our estimate should include compensation to the old boy for loss of income when we put in a bridge?

"I forgot to ask you about running through, or by-passing, villages. Where possible, I have taken the line through the larger villages, but in at least two cases, I have not done so. They were stuck on top of steep hillocks, so that the line through them would have cost a fortune. Surely they can move the villages on to the road? Don't they smell, too!

"I had the deuce of a time with the middle portion of the line. The map is certainly a little wild there. I am not surprised either, for the place was a vast swamp, black with mango flies and swarming with mosquitoes. I started down the line that we had marked on the map, but it was crossed by myriads of small streams, and there was no sign of any gravel for concrete. I tried another line farther north. This was much better, but still distinctly grim. I am trying a third alternative—to the south—on my way back.

"The last thirty miles are moderately easy, except for that range shown on the 1-in. sheet. Our line means a nasty climb up and down. I tried a lower saddle about five miles to the south, but the increase in length and the extra bridge to cross the Sokyukrum—I fell into this one, too!—cancel it out.

"The last obstacle is the River Dangumesu. At the moment it is over 100 feet wide. It is only four miles from this place. As it will be so close to roadhead, I think that it would be most uneconomical to put in a bridge, especially as there appears to be no rock for foundations. On the other hand, the locals swear that there is never less than 8 feet of water in the river, and I see no reason why a ferry, which would cost less than a sixth the price of a bridge, should not answer equally well. I have, therefore, chosen a crossing for a ferry.

"Reverting from one unpleasant subject to another, I shall have to sack my steward boy Kofi. He is the world's worst! He brought one candle for my filter and that a cracked one. He is the worst trekker in the party and is always last into camp. Last night my bed collapsed!!

"Please send some flour and some filter candles, which I have had to borrow from the D.C.

"What about my mail? Hasn't one of them written?

"Cancel my previous remark about staying here in peace and comfort. The sandflies are simply appalling. Life is one long itch! Please send the messenger to Cosikrum, where I am returning the

day after to-morrow to start reconnoitring that bad part where I had no luck coming out."

Letter from headquarters to senior subaltern :—

"Greetings, brother. Glad to hear that you are enjoying yourself! Sorry you had such a wet trip, but it is unavoidable if we are to see all the streams which dry up and disappear in the dry season. You now know why 'old coasters' are reputed to feel faint at the sight of water in a glass or out of it.

"We will let the Government haggle with the chief over the question of compensation for the loss of his ferry tolls.

"I think that you were quite right to go for a ferry site over the Dangumesu.

"I rather thought that Kofi was a bit of a blister. I have got another boy here standing by for you to see. He is a Grunshi and a likely-looking lad.

"You will be pleased to hear that there is a colossal mail for you, which I enclose. It appears that at least three of them have written, one at great length. Is that the one I fell over in the library at the last Chatham Ball? In any case, as I had to pay surcharge on the letter, will you please tell her to use thinner paper or get father to increase her stamp allowance!

"I also enclose a heavy official chit which has travelled a long way through devious channels. It alleges that before you quitted the old country you lost 'pokers, officer's, single, 1' and wilfully smashed 'some chinaware.' I remember the night well! Although entirely your fault, I will go fifty-fifty if you can't get away with it.

"Good paddling!"

(To be continued.)

THE CROSSING OF THE RU-KUCHUK.

OPERATIONS AGAINST SHEIKH ACHMED OF BARZAN, KURDISTAN, 1932.

By MAJOR P. W. CLARK, D.S.O., M.C., R.E.

THE operations to bring under administrative control the area of Iraqi Kurdistan, lately under the influence of Sheikh Achmed of Barzan, were commenced in early March, 1932; the ground troops engaged being units of the Iraqi Army. The Royal Air Force and one flight of the Royal Iraqi Air Force co-operated with the ground troops by affording close co-operating machines for all moves of the Iraqi Army columns, and also took independent air action against the rebels when considered expedient.

The main column moved off north from Diana on March 15th, 1932, with four British officers of the British Mission to the Iraqi Army to assist the column commander in an advisory capacity. A Royal Air Force officer with two wireless operators accompanied the column, for liaison duties with the Royal Air Force.

The country traversed was mountainous, with peaks up to 8,000 feet. The tops of the hills were rocky and the lower slopes and valleys often heavily wooded. Small mountain streams abounded but were easily fordable.

The progress of the column was first opposed by the followers of Sheikh Achmed by determined night attacks on the camps, which, however, were all beaten off with loss to the enemy. On April 3rd, the main column was attacked in daylight on the line of march. On this occasion the enemy chose his place and time of attack wisely, and the column lost heavily in personnel, animals and stores. This reverse, however, was wiped out three days later by a well-conceived and executed combined ground and air attack on a large enemy concentration. The enemy losses on this occasion were very heavy, whilst our losses were small. During this action the co-operation between the ground troops and the air forces was excellent, and the perfect way in which the striking power of each was made the complement of the other's undoubtedly was responsible for much of the success.

Following these engagements the column, always most adequately shepherded from the air by the R.A.F., moved throughout the area as far north as the River Ru-Kuchuk and established a number of well-sited, strongly-fortified posts in selected strategical positions. These posts, rationed for at least thirty days, had adequate supplies of water and were in W/T communication with the Force Headquarters in Diana. Constant patrolling between these posts and

regular bombing by the R.A.F. of known hiding-places of the enemy within this area brought about the withdrawal of the enemy forces to the area north of the Ru-Kuchuk, that is bounded on the north and east by Turkey and on the west by the three parallel ranges of mountains that run approximately north and south. (Plate I.)

The area to the west of these parallel ranges of mountains had been cleared of the enemy forces by a column based on Bille.

The R.A.F. then began a programme of intensive bombing of the enemy concentrations north of the River Ru-Kuchuk.

This was the position at the end of May.

It was thought that the forcing of a decision by air action alone might be a protracted operation. In consequence it became necessary for the ground troops to follow the enemy and attempt to engage his forces in the area to which they had retreated.

The three ranges of mountains to the west of the area in question were deemed an insuperable barrier to the passage of, and subsequent rationing of, a strong column. It became necessary, therefore, to force a crossing of the river.

The choice of a place to attempt the crossing was practically decided by the topographical features of the country through which the river ran. For practically all its length it ran at the bottom of a deep rocky ravine. The valleys at Zerara and Chama were the two exceptions. A crossing at the former, however, would only have given access to the small triangular area around Kani Bot, which is hemmed in by high and very steep hills, over which there was no suitable route to the enemy positions in the country to the north-east.

In consequence the decision to cross near Chama was made, and the writer and Major R. S. M. White, O.B.E. (Leicestershire Regt.), carried out a reconnaissance of the river in the vicinity of this village on May 20th. The site for the crossing favoured by them, and eventually chosen by Major-General Rowan Robinson, C.B., C.M.G., D.S.O., the Inspector-General of the Iraqi Army, who made a reconnaissance of the river in early June, was ideal tactically. The opposite bank and all approaches to it were commanded from our side of the river, whilst a fairly steep cliff on the north bank afforded protection from long-range sniping to those working down by the river. It was felt that we so held the whip-hand that, with the R.A.F. above us, we could afford to drop all secrecy and go ahead and practically invite opposition as a means of getting to grips with the enemy who had proved, during the previous six weeks, to be very elusive.

The river at this point was 45 yards wide and the stream in the centre was running at from five to six miles per hour, as the snow on the high hills of its source had not finished melting. The river rose each night, with a corresponding increase in the velocity of its stream, and dropped again during the day, commencing to fall about 10 a.m. each morning. This variation, which amounted to as much

as a foot, indicated the great differences in day and night temperatures at the source of the river and the time taken for the melted snow to reach Chama.*

Both banks were sandy and slightly wooded and the approaches fairly easy. No local materials except eight poplar trees were available.

Realizing that the whole of the bridging materials would have to be brought from the base by pack transport, the writer recommended that the crossing should be effected by rafting, as, until the river dropped and the stream slackened, it would be inadvisable to rely on the satisfactory erection of a floating bridge of a type capable of being transported to the site by pack transport. A list of the rafting stores required and a specification for the rafts were forwarded to Baghdad.

The concentration at Kani Linj of the column to cross the river was completed by early June, and notification was received that the rafting stores and also a floating bridge was on its way up. Photographs of a section of the bridge which had been constructed in the Baghdad Ordnance Workshops to the design of Capt. A. H. Kemp, R.A.O.C. (R. of O.), and details of its construction were received about this time.

As the studying of these photographs and description of the bridge led the writer to come to certain conclusions, and influenced the programme of work, it will be as well to go into the details now.

As can be seen from Photos 1, 2 and 3, the bridge was made up of a number of inverted boxes or sections one yard square, each filled with inflated sheepskins; the several sections being fixed together by lashing them to longitudinal and transverse bamboo struts. It was realized that the structure would be springy enough to compensate for the fact that it was not articulated, but at the same time the lateral strength and rigidity would be very small and great care would have to be taken with the anchoring and staying of it upstream until the speed of the current had slackened considerably. This difficulty of anchoring was further complicated by the fact that the bridge lacked definite piers upon which to concentrate. It was also realized that, as the bridge was of the continuous floating-mat type, its erection across the river would tend to dam the river very considerably, and, with ordinary anchoring, if the upstream edge was unduly loaded, there was every possibility of the current forcing that edge down and wrecking the bridge.

* This daily rise and fall of the river was not ascertained until about June 10th. Readings of the level of the river had been taken daily from May 18th. These readings, however, were not taken at the same time each day, as the river could only be approached from the camp at Kani Linj with an adequate covering party, and the garrison at Kani Linj post had numerous patrols and other duties to perform, making a daily fixed time for the reading of the level of the river difficult. In consequence, the series of readings obtained were very misleading and afforded no true indication of how the river was going down. This diurnal rise and fall is probably a characteristic of many mountain rivers.

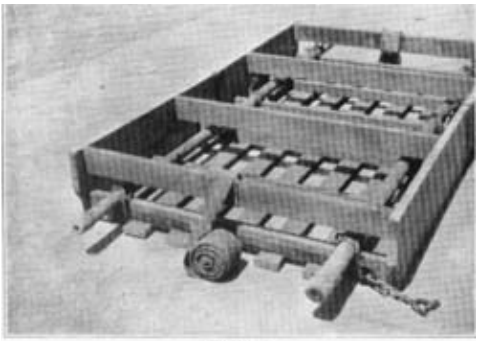


Photo 1.

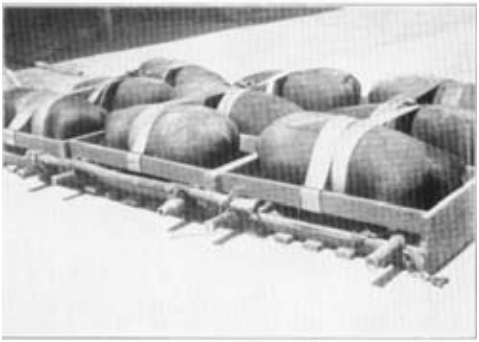


Photo 2.

Photo 3.—Details of the Bridge.

The crossing of the Ru-Kuchuk 1-3.

Royal Air Force official. Crown copyright reserved.

Photo 4.—The Crossing in progress.

The crossing of the Ru-Kuchuk 4

The following day, as the rafting stores had arrived from Baghdad, the work of the construction of the ferries was commenced. Meanwhile, the ropeway was utilized to get across further troops and stores to make good the opposite bank.

It was decided to make the main ferry one in which a raft, working along a cable, would be hauled from bank to bank. Heavy, well-anchored gins were constructed on each bank and a light wire rope (of the heaviest section that could be transported to the site by pack transport) was stretched across the river between them. Special attention was paid to the construction and anchoring of this suspension cable, as it was the intention, as mentioned above, to utilize it later in the construction of the bridge. Meanwhile the assembling of the rafts, by the carpenters who had made them in Baghdad, was proceeding. The main raft, 12 ft. x 12 ft., was constructed of *bullies* bolted together and carefully cross-stayed. The whole formed an inverted lidless box and the inside was filled with inflated sheepskins tied in position with the cords that closed the leg and neckholes of the skins. This raft was to all intents and purposes a copy of the ordinary " Kellick " used on the River Tigris, with the exception that bolts and suitable fastenings were substituted for the rough grass cordage that is usually used to hold these structures together. Iron tethering rings were provided for attaching the hauling ropes and also the ropes leading up to the snatch block running on the steel suspension cable.

Numerous experiments were made to determine the best place for the haulage ropes to be attached, and in the end the arrangement shown in Plate 2 was adopted. By this arrangement, directly a shore gang starts pulling on their haulage rope, the raft is slewed across the stream and the current begins to help the crossing of the raft on the principle of the flying ferry. Once the best position for the points A and A1 are ascertained and the shore haulage ropes are fixed, the slewing of the raft across the stream every time it starts a journey across is automatic, and there is none of that lengthening and shortening of ropes as in the ordinary flying ferry. The fact that the sheepskins were laid in rows with their long axes parallel to the run of the river, probably accounted for the great assistance the stream gave the shore gangs once the system was adopted.

The landing stages were constructed last with rock and sandbags, and were made to conform with the natural position the raft assumed at each bank as it was hauled in. This arrangement proved to be very satisfactory, and did away with the necessity for warping lines, etc. An auxiliary raft, 9 ft. x 9 ft., was constructed of nine " sections " of the bridge but was not provided with any traveller, being merely pulled from bank to bank by ropes. It was found difficult to work in the fast current and was not very satisfactory.

The gangs hauling the rafts from bank to bank lay on the ropes and walked away from the river, the leading men dropping off after

Now, normally, the problem of erecting a floating bridge in a strong current can be subdivided into a number of lesser problems, each consisting of the erection of a pier and bay. This convenient subdivision of the problem could not be applied, and the writer found it necessary to approach the problem of erecting the bridge as an entirely new one, demanding if necessary unorthodox methods.

The decision was made, therefore, to erect an overhead suspension cable to act as a traveller rope for the ferry rafts, in a position and of sufficient strength for it to be utilized subsequently in the construction and anchoring of the bridge.

Whilst awaiting the arrival of the rafting and bridge stores, the approaches to the river were improved and a track from the column camp at Kani Linj to the river constructed. Meanwhile the 30 O.R's, detailed from the infantry (the Iraqi Army has no engineer troops at present) for the construction of the ferry and bridge, were given some instruction in knotting and lashing and the erection of shear legs, gins and log anchors.

Later the bridging party, covered by troops from the main camp at Kani Linj, experimented down by the river with the only stores they had, namely, 50 fathoms of 4-in. rope, 100 fathoms of 2-in. cotton rope, one 4-in. snatch block and some coils of D3 telephone line. A telephone line was got across by ten swimmers, spaced at suitable intervals along the line that was buoyed with dry gourds that were found locally. With the telephone line we got over first the 2-in. cotton rope and then the 4-in. manilla. The 4-in. rope was stretched between two suitable trees, one on each bank, at a height of about 15 ft. above the level of the river, the snatch block fixed to run on it and the centre of the 2-in. rope fixed to haul the snatch block from bank to bank. Platforms of rock and sandbags, with steps leading up to them, were erected on each bank to enable the hook of the snatch block to be reached.

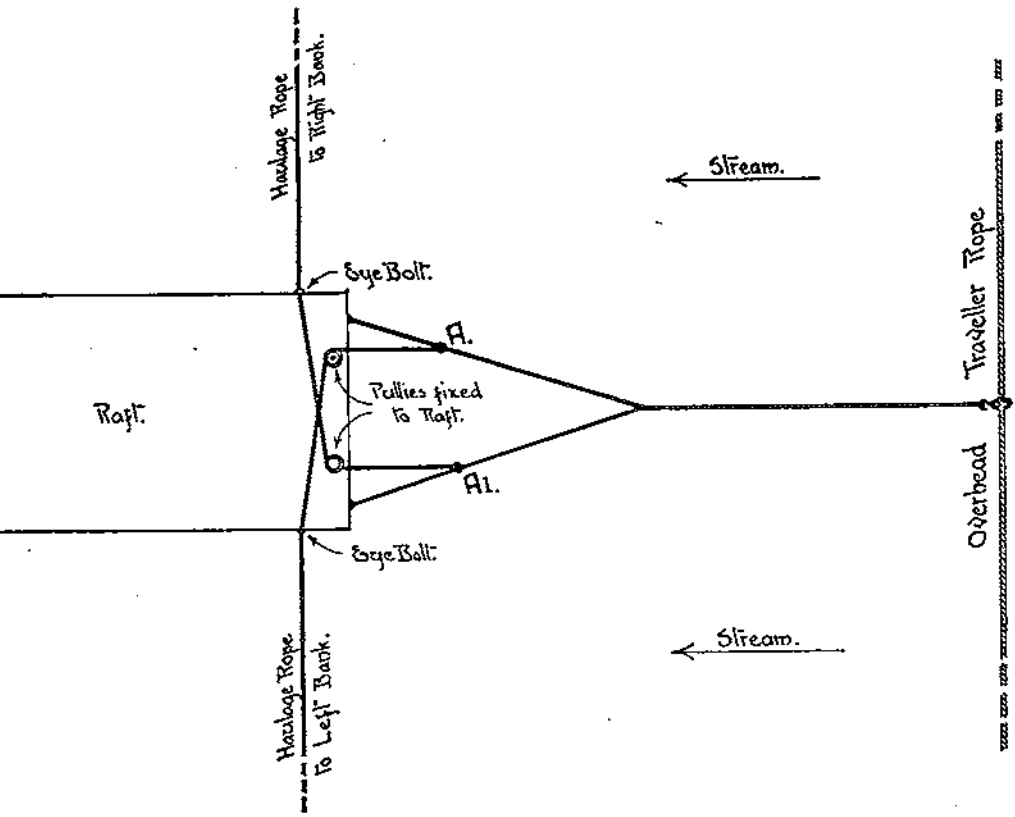
Originally this means of crossing was only intended for the use of the bridging party, but as our activities down by the river had not induced the enemy to oppose us in any way, it was decided to utilize it, the day after it was completed, to get across the troops and stores necessary to establish a small well-wired post on the north bank as the nucleus of the bridgehead.

The following day, therefore, this one rope was used to pass over two platoons of infantry, one M.G. platoon (two Vickers guns), a working party and all necessary stores. All men who could swim well swam over, their clothes, arms and accoutrements being sent over in sacks. The non-swimmers sat in a sling attached to the snatch block and were hauled over. The crossing of this party was made without any accident, except for the loss of two coils of barbed wire due to bad slinging. By the evening the sangar was completed, wired, rationed and in telephonic communication with Kani Linj, and the working party was back in the main camp.

having gone twenty yards and doubling down to rejoin the rope again at the river bank. This method gave a steady pull on the haulage rope and kept the ropes out of the water—an important point with a stream running fast.

On the 14th June, the crossing of the river by the column was commenced at dawn (0400 hours) and went on continuously until nightfall (2000 hours), by which time two infantry battalions and half a 3·75 mountain battery, complete with their first and second

PLATE 2.



line transport, were across and a perimeter camp on the north bank of the river established.

The effect of the current was so severe that the loading of the rafts had to be kept down to 16 armed men on the large raft and six on the small raft at one time. That such a large force was got over in so short a time indicates how well all ranks worked.

Whilst the troops and stores were being rafted across, a picked party of ten swimmers, slightly higher upstream, swam the animals over. The problem of how to swim the animals over had worried the British officers with the column for some time and numerous methods had been considered. As the water was snow water, very

cold and running at about six miles per hour in the centre of the stream where the animals had to cross, we all anticipated that a certain number of them would be carried downstream and drowned in the rapids below. By the end of the day, however, over 300 animals had been got across without the loss of a single one of them, and every animal detailed to make the crossing had been got over.

This result was achieved by ten other ranks of the Iraqi Army—all picked swimmers, who were in the ice-cold water off and on from 0400 to 2000 hours. Their magnificent physique, pluck and amazing skill as swimmers were responsible for the result. These men, one to each animal, led the animals down into the water by chains attached to their head collars, whilst a party on the bank with sticks urged the animals down. Once in the water the tussle commenced, as the majority of the animals tried to turn back the moment they slipped into deep water (the banks shelved very steeply). The men, by sheer quickness and strength in the water, kept the majority of the animals' heads upstream and making for the opposite bank. Many of the animals reared up in the water and struck out with their forelegs momentarily above the surface, but no one was injured whilst in the water. Many animals swam over on their own accord when given a lead by an animal accompanied by a man.

Those animals that defeated the men and got back to the bank, joined the next party of animals to cross, and at the end of the day, by this process of elimination, a choice collection of rogues remained to be got across. The very last animal of all took fully eight minutes to make the journey and was very exhausted with his struggles when he reached the opposite bank. The "Jundie" who had got him across got well-earned applause from the troops on the banks.

It is interesting to note that, a few days later, large parties of animals that had swum the river a few times, only needed to be led down to the water for the whole of them to go in of their own accord and swim in a body to the opposite bank.

The very quick results obtained from practising horses and mules in swimming was well demonstrated.

The swimming of the river was not confined only to men, horses and mules; our meat rations on hoof—sheep, goats and bullocks—also made the journey.

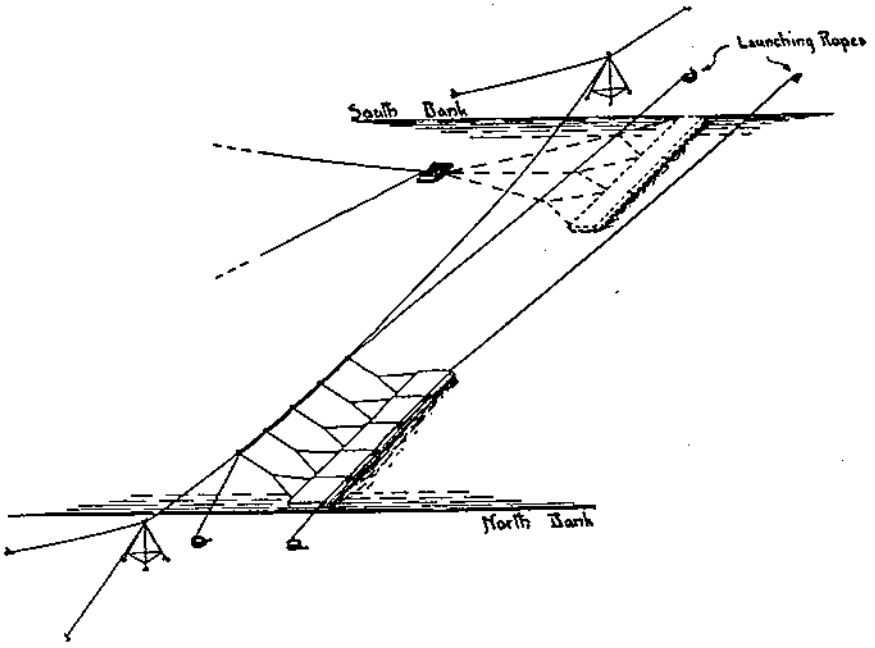
The following morning, an hour before dawn, the column moved off north to attack Shirwan-a-Mazin, at which place it was known a party of the enemy had been concentrated whilst the crossing of the river was in progress. The village and the many caves in the vicinity were found empty, and the column returned to its camp by the river. Directly sufficient rations had been got across the river for the whole force for 30 days, the column again advanced north to Shirwan-a-Mazin. There it constructed a fortified L.-of-C. post for a garrison of one company of infantry and a machine-gun platoon,

before pushing on north towards Zaita, on the Turkish frontier, to which place Sheikh Achmed and his followers had retreated.

The writer then returned to the river to construct the bridge, as the stream had slackened a little, and it was anticipated that the traffic across the river would be considerable with a column operating to the north of it.

The putting together of the sections of the bridge was done on the south bank. The bridge was made three sections wide (9 ft.), as it was intended that the bridge should be fit for pack transport. The bridge was built up on the bank in three portions, each portion being

PLATE 3.



approximately 42 ft. long. This work took a considerable time to complete. As each portion was completed, it was transferred to some slack water on the opposite bank by attaching one end of it to the snatch block on the traveller cable, in place of the ferry raft, and hauling it over. No trouble was experienced, as the long axis of the portion of the bridge was parallel to the current and practically no strain was put on the structure.

When all three portions of the bridge were in the slack water on the north bank, the first to be put in position was swung out and attached, at regular intervals, to five snatch blocks equally spaced by short ropes and running along the traveller cable. (Plate 3.) This portion was then launched across the river to the south bank by ropes

PLATE 4.

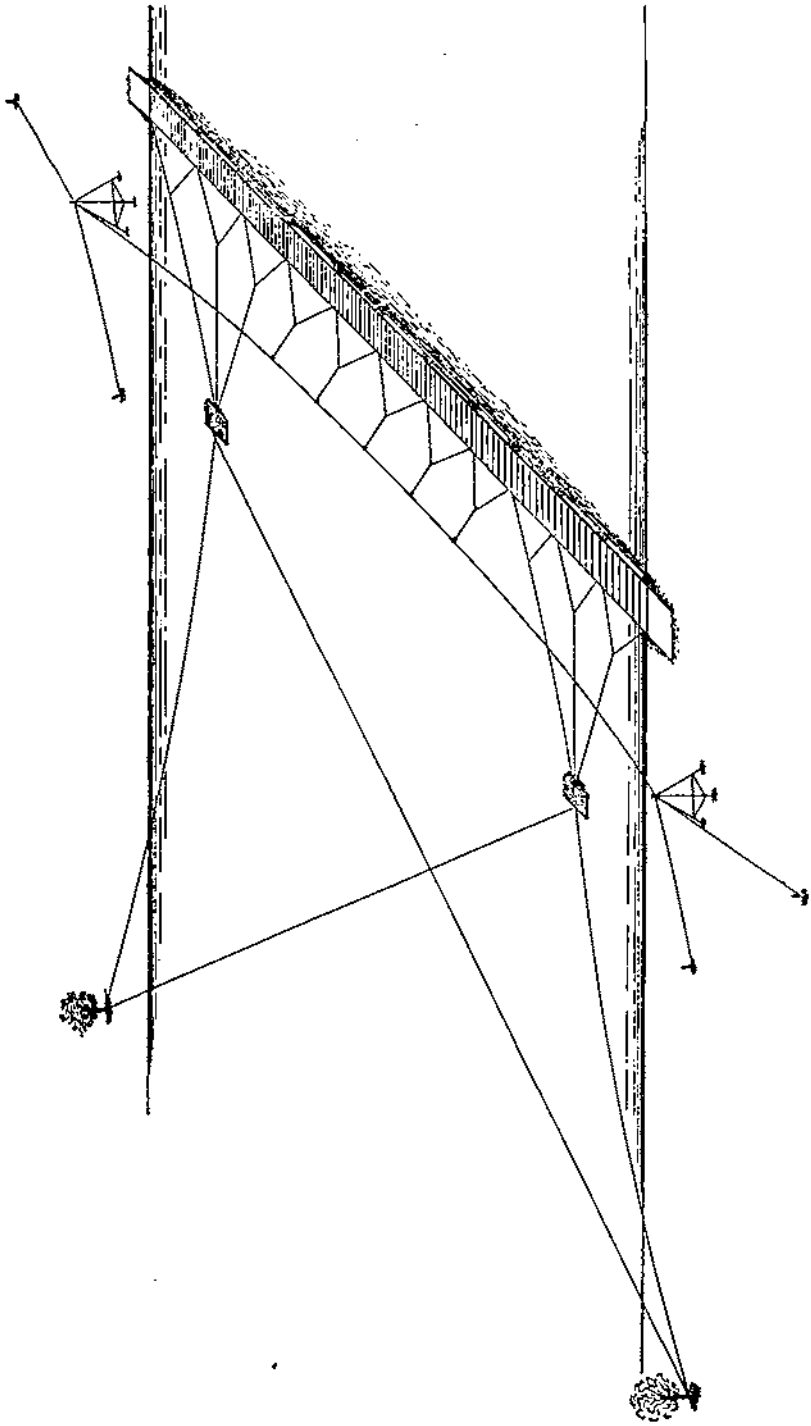
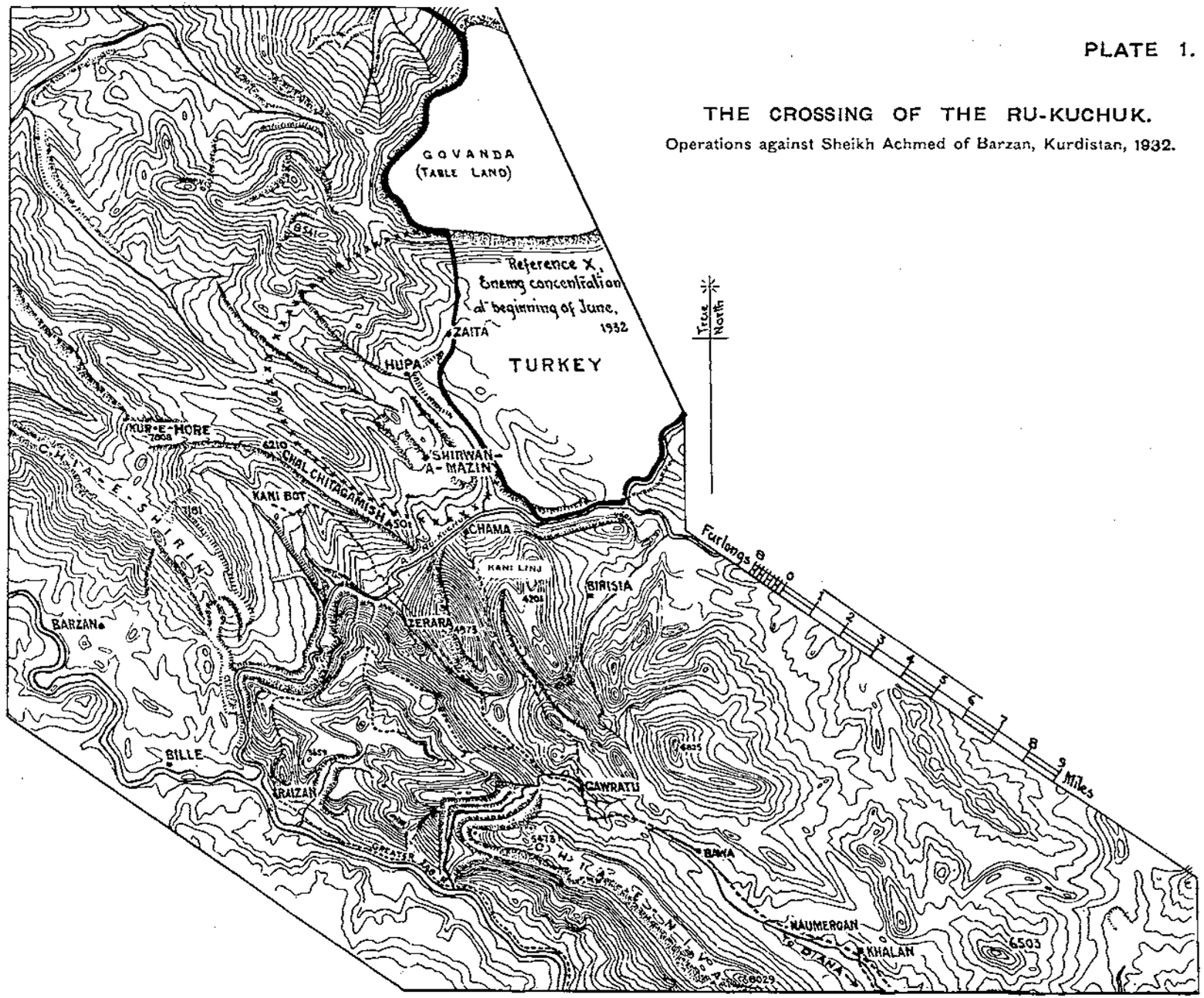


PLATE 1.

THE CROSSING OF THE RU-KUCHUK.

Operations against Sheikh Achmed of Barzan, Kurdistan, 1932.



attached to the end blocks and also to the ends of the portion of the bridge itself.

On arrival in position on the south bank, this portion of the bridge, which was not greatly affected here by the force of the stream, was anchored back to a buoy, constructed of two sections of the bridge which had previously been anchored in position. The five ropes up to the blocks on the suspension cable were taken off and the string of blocks hauled back to the launching bank.

The centre portion of the bridge was then attached to the string of pulleys on the overhead cable and hauled over in the same way as the first, except that the anchoring of this portion of the bridge to a buoy was not attempted. It was left attached to the string of pulleys used to launch it. The two portions of the bridge being slightly out of alignment, called for rather delicate adjustments to be made to the anchor lines of the first portion launched. Eventually the two portions were in perfect alignment and joined together by lashing in place the necessary longitudinal bamboo struts and coupling up the side chains.

The full force of the current on the centre section of the bridge put a big strain on the overhead steel rope, but the bridge itself rode the stream very steadily. The launching of the last portion of the bridge and the anchoring of it back to a buoy was a simple affair, as the water near the north bank was practically slack.

When completed, therefore, the shore portions of the bridge were anchored back at intervals to buoys, whilst the centre portion anchor ropes were all carried up to spaced pulleys on the overhead suspension cable. (Plate 4.) The bridge, therefore, could be described as a mat-type floating bridge, with the upstream side of the centre portion reinforced by one cable of a suspension bridge. Over 220 inflated sheepskins were used in its construction.

This bridge was the first ever constructed by the Iraqi Army, and incidentally it was the first time any army had crossed the Ru-Kuchuk from south to north ; the Turks having found it an impassable obstacle on more than one occasion.

The success of the operation was primarily due to sound judgment as to where to attempt the crossing. Given time and reasonable security at a river, the technical difficulties can generally be surmounted. That those at Baghdad when designing and constructing the bridge stuck to materials, methods and customs indigenous to the country, also helped enormously. Except for a few skilled hands from the Ordnance Workshop, the whole work at site was carried out by unskilled men from the infantry battalions.

One could not have wished for more willing workers. Their lack of knowledge and skill, however, resulted in the writer undergoing a very useful refresher course in knotting and lashing, as the whole of such work had to be done by him.

A STAFF EXERCISE IN BELGIUM.

By CAPTAIN A. C. SHORTT, R.E.

A STAFF exercise was held at Middelkerke, Belgium, from the 2nd to the 6th October, with the object of " considering the problems, tactical, engineer, and administrative, which might confront a force after making a successful forced landing on an enemy coast."

The exercise was based on the operation which it was intended should be carried out by the 1st Division in the summer of 1917 on the Belgian coast between Ostend and Nieuport. The scheme is fully described in an article by the Director published in *The R.E. Journal* of June, 1924 : it is not, therefore, proposed to go into it in very great detail here. Briefly, the plan was for the three brigades of the 1st Division to be landed at dawn from specially constructed pontoons at three selected points behind the German lines between Ostend and Nieuport.

The strategic policy of the British Army in 1917 was governed by two main considerations : (i) the failure of the French attack in Champagne, and (ii) the increasing gravity of the submarine blockade. The 1st Division landing was planned as part of a big attack by the Fifth Army, which, in conformity with the general policy, had as its threefold object the distraction of as many German divisions as possible from the French front ; the capture of ground from which heavy guns and howitzers could shell the submarine bases at Ostend and Zeebrugge ; and the destruction of certain troublesome batteries at Raversyde on the outskirts of Ostend. The landing was to have been contemporaneous with an attack by the XV Corps in the coastal sector in front of Nieuport, both operations being dependent upon a successful advance by the Fifth Army north of Ypres. The Fifth Army attack was a failure and the plan was never put into operation ; but the preparations and training for it reached an advanced stage before the project was finally abandoned, and one object of the exercise was to study the ground over which the left Brigade of the Division would have operated, in order to arrive at an estimate of its chances of success had the landing ever been attempted. Particular interest attached to this part of the exercise owing to the existence of many of the old German concrete defences, still in a fair state of preservation, which gave to the scheme an atmosphere of reality lacking in the normal peacetime T.E.W.T.

Major-General W. G. S. Dobbie, C.B., C.M.G., D.S.O., who directed the exercise, was responsible, as G.S.O.1 of the 1st Division, for much of the preparatory work carried out in the summer of 1917. In a lecture given in the S.M.E. Theatre, on the Friday preceding the date on which the exercise was due to commence, he gave a detailed description of the plan itself and of the meticulous care which was taken to provide for every eventuality and so ensure every possible chance of success. In order to train for the operation the 1st Division was withdrawn from the line and accommodated in an enclosed camp at Le Clipon, six miles west of Dunkerque. Elaborate precautions were taken to maintain absolute secrecy, and all intercourse with the outside world was forbidden: permanent piquets were on duty on the perimeter, and all letters were subjected to a rigorous censorship. The R.E. work in connection with the camp fell upon the shoulders of Colonel C. Russell-Brown, C.B., D.S.O., the C.R.E. of the 1st Division, who was fortunately able to accompany the party to Belgium and give a first-hand description of the tasks with which he was faced.

The pontoons from which the landing was to have taken place were the invention of Admiral Bacon, of Dover Patrol fame. Each was 600 feet long by 30 wide, and capable of carrying a Brigade Group complete. Each was propelled through the water by two monitors fastened abreast against its rearward end, and for the actual landing the pontoons were to have been pushed up under cover of darkness as close as possible to the sea wall to allow the attacking troops to rush ashore and establish themselves before the enemy could collect sufficient troops to stop them. The loading of these pontoons was very carefully thought out and by repeated practice on a model constructed on the ground inside the camp the time of disembarkation was reduced from 50 to about 10 minutes. A model of the sea wall was also provided in order that the troops detailed for the assault and the tanks which were to have accompanied them should have practice in scaling and surmounting it. On another model was shown every detail of the coast so far as could be ascertained from aeroplane photographs, direct observation by telescope, picture postcards and photographs taken prior to the German occupation, and local information. On the model each object was, when possible, shown in its natural colours.

The reader is referred to the article mentioned on page 596 for a fuller account of the work carried out at Le Clipon camp.

A third participator in the original operation was present in the person of Colonel W. Garforth, D.S.O., M.C., late O.C. of the 430 Field Company, 66th Division, XV Corps. The Inspector, Royal Tank Corps, Brigadier P. C. S. Hobart, D.S.O., O.B.E., M.C., acted as expert adviser on tank matters; Lieut. J. H. Unwin, R.N., and Squadron-Leader P. F. Fullard, D.S.O., M.C., A.F.C., represented the Royal Navy

and the Royal Air Force respectively, and 38 officers attended under instruction: 3 from R.A., 26 from R.E., 1 from R.C. of S., 6 from Infantry, 1 from R.A.S.C., and 1 from R. Marines. The latter were organized in six syndicates.

The exercise was confined to a study of the tasks of the 2nd Brigade, which, as left brigade of the 1st Division, was to have landed at Middelkerke, established a bridgehead, destroyed the two coast batteries at Raversyde, and seized an important canal bridge at Slypbrug, about two miles inland from Middelkerke. For the purpose of the exercise the Brigade Group comprised, in addition to its four infantry battalions, a light battery, a field company, a cyclist battalion, 3 medium tanks, a section of light tanks, a detachment of a field ambulance, and two motor vans.

* * * * *

On the morning of October 2nd the party, accompanied by the wives of five of its members, embarked on the mid-day boat at Dover, arriving at Ostend at about 4 o'clock. The Channel was tolerably kind and, so far as can be ascertained, there were few, if any, casualties. The "Q" arrangements, organized by Captain G. N. Russell, worked without a hitch, and at Ostend Station a convoy of cars and chars-a-bancs was waiting to transport the party along the four miles of coast road to Middelkerke. Accommodation was provided at the Grand Hotel de la Plage, where, considering that it had been reopened solely for the use of the party, and that all the functions of a hotel *ménage* were performed by a small cadre staff of servants, a satisfactory degree of comfort was provided.

Middelkerke is a small watering place to the west of Ostend, with two large hotels, a number of houses of the "board residence" type, a Kursaal, two main streets of shops, and one road running inland through the village of Slype in the direction of Dixmude. During the war it attained to some importance as the Headquarters of Admiral von Schroeder, the Commandant of the German Marine Corps. The Admiral and his Staff were housed in a massive concrete structure which is now used as a War Museum, where relics of the German occupation may be seen for the sum of two francs, and where, with a little encouragement, the voluble caretaker will purvey information on almost any subject, from the number of rounds fired by any given gun to the strategy of the German Higher Command.

After an adequate dinner at which *rosbif à l'Anglais*, in slabs $\frac{3}{8}$" thick, figured as the principal item, a conference was held in the hotel ballroom. The Director amplified his previous instructions, criticized the syndicates' solutions to the first problem, and issued Requirement 2, which concerned the orders to the Field Company prior to landing.

And so to bed.

* * * * *

Photo No. 1—Showing mouth of the Yser, and part of area occupied by Left Battalion before German attack on 10th July, 1917. Wreckage of bridges can be seen in river.

A staff exercise in Belgium 1

Photo No. 2.—Middelkerke—the Site of the Proposed Left Landing of the 1st Division.

A staff exercise in Belgium 2

Thanks to an indifferent appreciation of the situation by the hotel management, the first objective the following morning, namely breakfast, was not obtained without a certain amount of "offensive action," as the provision of bacon and eggs in bulk appeared to impose a severe strain upon the slender resources of the staff. However, with one exception, the whole party contrived to be present at the meet, which was ordered for 9 o'clock on the beach. The solitary absentee, who appeared some time later in the morning, was understood to say that he had "been to Slype."

Work began with an inspection of the proposed site for the 2nd Brigade landing. This was to have taken place at high tide at a point opposite to the Dixmude road. Jutting out from the sea wall at approximately the middle of the esplanade is a small promontory on which stands Middelkerke Kursaal. Here, obviously, lies the greatest potential source of danger to a landing force, since it acts as a bastion from which enfilade fire could be brought to bear along the whole length of the foreshore. Syndicates agreed that the first task of the guns supporting the landing would have been to reduce this portion of the front by intensive fire. In view of the better facilities for deployment offered by the Dixmude road, it was also agreed that the site selected was probably the best. A suggestion was made that a landing at the point of the Kursaal promontory might have met with greater success, as the machine-guns sited in the building would have been partially masked. The difficulty of unloading stores, however, seemed to preclude this, as the water rises to a considerable depth here, and it is doubtful whether it would have been possible to remove the stores sufficiently quickly.

The action of the force subsequent to landing was then studied, based on the assumption that complete surprise had been effected and the first objectives secured without serious opposition. Syndicates were required to point out on the ground the dispositions of the assaulting battalions on the first objective; to define the tasks which would have been allotted to the sections of the Field Company; and to decide upon the measures necessary to protect the left flank from counter-attack from the direction of Ostend. There appeared to be a considerable divergence of opinion, but it was generally agreed that the force would have been extremely cramped unless the leading troops had been pushed farther forward than was envisaged in the original plan. The Director stressed the importance of using the Sappers economically by (i) knowing their capabilities and limitations and (ii) giving them clearly defined tasks requiring specialized knowledge or equipment, as opposed to unskilled work which could as well be performed by other arms.

Plans now had to be made and orders issued for the action of the flying column detailed for disabling the guns in the Aachen and

Antwerpen batteries at Raversyde, about 1½ miles along the coast in the direction of Ostend.

Three roads lead from Middelkerke to the battery positions: (i) the esplanade running along the edge of the sea wall; (ii) a winding unmetalled road about 150 yards inland, separated from the first by undulating scrub-covered dunes; and (iii) another metalled road parallel to the sea wall 250 yards inland. At right angles to the line of approach and just short of the nearer of the two batteries ran a German reserve line, shown on the map as consisting of a few scattered trenches protected by a double belt of wire. This line had to be negotiated before either battery could be reached, but according to the Intelligence reports the line was not manned at the time when the operation was planned to take place.

The column consisted of a battalion of cyclists, a section of light tanks, three medium tanks, a section of the Field Company, and a company of infantry with a platoon of machine-guns. A representative from each syndicate was required to give verbal orders to each of the units taking part, and here again there was a wide divergence of opinion as to the best method of dealing with the problem. An advance by bounds appeared to be necessary in view of the position of the German reserve line, but on the other hand speed was of vital importance if the work of destruction was to be completed before the arrival of enemy reinforcements. The solution appeared to be a judicious blend of boldness and caution, the tanks being sent ahead to overcome any resistance on the reserve line, followed by the cyclists, who were to occupy this line and push out one or two companies to act as a covering force during the demolition of the guns. The chief role of the infantry would be to occupy a position from which they could cover the withdrawal of the force on completion of the work. Syndicate solutions were discussed and criticized, and Brigadier Hobart was asked to give his views on the employment of tanks in this type of country.

After an interval of an hour for lunch the exercise was resumed from the point where the column would have crossed the reserve line. A closer examination of the ground disclosed the existence of a number of concrete pillboxes, well concealed and covering all lines of approach to the batteries. These were not marked on the maps issued for the operation. Plans were now re-examined in the light of this fresh information, and syndicates were asked to decide what modifications, if any, would have been necessary in their own plans in order to meet the situation.

As regards the technical aspect of the task, the guns had, of course, been dismantled, so that the methods and quantities of explosives necessary to disable them were largely conjectural. A highly controversial problem was nevertheless provided, and the most striking fact which emerged from the discussion on the subject was the

measure of disagreement among the Sapper elements present. General vagueness was apparent with regard to the properties and use of thermite, and some remarks made on the subject by the Chief Instructor in Fortification, S.M.E., left the impression that too much reliance was not to be placed in its efficacy for the present purpose unless it could be used in considerable quantity at the muzzle end of the gun. The use of guncotton for damaging the breech mechanism was considered, as was also the possibility of blowing up the magazines. No definite conclusion was arrived at as to which of the many suggested methods would have produced the greatest effect, but it is hoped to publish another article shortly dealing with the technicalities of this particular problem.

Work for the day was concluded by a consideration of the dispositions of the covering troops while the preparation of the charges was in progress, and of the arrangements for the eventual withdrawal. The Director in his comments emphasized the necessity for a close support of the Sappers by infantry posted inside the battery positions to deal with any parties of the enemy who might have been overlooked during the attack or who, by taking shelter in dugouts or magazines, had escaped observation.

After tea several officers took the opportunity to visit the War Museum, where a comprehensive collection of relics and photographs gave an insight into the thoroughness of the German organization for the defence of their Channel ports. The position of this headquarters was kept a close secret from friend and foe throughout the length of the war. It was not known to us at the time.

* * * * *

On Wednesday morning the operations of the second column were studied. The task of this column was to seize Slypbrug, a small village where the Slype road crosses the Ostend-Nieuport canal by a swing girder bridge, and establish a defended bridgehead there. The detachment comprised a battalion of infantry, a section of the Field Company, and a company of cyclists, with a section of the light battery in support. The main problem studied was the organization of the defences of the bridgehead, with special reference to the tasks allotted to the R.E. in the work of defence. For the purposes of the exercise it was assumed that some minor opposition was offered to the advance of the column, and one or two elementary problems were set involving the action of an advanced guard.

The country between Middelkerke and Slypbrug is flat and open; low hedges by the roadside and small folds in the ground affording the only cover. A German defence line, including pillboxes and wire, ran roughly parallel to the road about ¼-mile to the west, while sited on either side of the road were scattered pillboxes, some of

great strength, which would probably have proved a source of trouble to the advancing column. With one exception syndicates proposed to use the cyclists as advanced guard mobile troops, but the Director dissented from this view, holding that they would be of greater value used on patrol work for the defence of the bridgehead. He pointed out that, used as cyclists, they would be tied to the road, where they would be extremely vulnerable, and if, as they were almost bound to do, they deployed off the road, their value as highly mobile troops would be sacrificed. He therefore suggested an advanced guard consisting of a company of infantry moving in diamond formation with the main body about ½-mile behind, cyclists in rear, keeping east of the road so as to avoid possible interference from the enemy reserve line to the west.

The defence of the village fell fairly simply into sectors, and thanks to the open nature of the country a close defence was possible. Excellent all-round observation was obtainable from the upper rooms of the houses and from the top of a large brick-stack on the north bank of the canal. Tasks which the R.E. would have been required to perform included the blocking of approach roads; the construction of O.P's and m.g. positions; the improvement of communications across the canal by the use of barges or by the construction of spar bridges with telegraph poles, of which there were a number near the site; and investigation, and improvement where necessary, of the local water supply. Syndicates were asked to give an order of priority for these tasks, and a R.E. officer from each syndicate was detailed to describe how he would set about carrying out the orders of his syndicate commander.

This completed work for the day, and the party were free to indulge their individual tastes until 9 p.m. The majority went off sightseeing to Bruges and/or Zeebrugge, but a few keen students spent the time subjecting the German defence works to a more critical examination than had been possible on the previous day.

As this also completed the part of the exercise which was directly concerned with the operations of the 2nd Brigade, a conference was called after dinner to discuss the general lessons which had emerged from the two days' work. Before the conference started the Director was asked to make a small presentation to the leader of No. 2 syndicate on behalf of the other members. The presentation took the form of a foot or two of choice Belgian cigar at 3 francs the foot. When last seen, late at night, the recipient was entering upon his third hour and last six inches, putting up a good fight against hopeless odds.

Squadron-Leader Fullard was asked to open the ball with some remarks on the air aspects of the scheme. He gave an admirable disquisition on the functions of an Army Co-operation Squadron in an operation of this kind. The tasks which it could be expected to

perform included the taking of vertical and oblique photographs of the enemy's positions during the preparatory stages; artillery reconnaissance; close reconnaissance; ranging for counter-battery work, in which connection he stated that six batteries could, on the average, be neutralized in two hours; bombing; machine-gun support of ground troops (though this was not advisable in the earlier stages of the operation); the dropping of S.A.A. to forward troops; and the laying of smoke screens. Equipment for the latter task was not yet general, but as things were at present it could be done if special arrangements were made. He stressed the importance of carrying adequate W/T and R/T equipment to facilitate communication between air and ground.

Lieut. Unwin gave an estimate of the efficacy of naval guns against fixed land defences protected by long-range artillery.

A point was raised that use might have been made of captured German machine-guns, and that a percentage of men taking part in the landing might have been trained in the use of this weapon during the preparatory stages.

The Director then summed up the broad lessons of the exercise. These were:

(i) That a commander must have a clear appreciation of (*a*) the object of the operation; (*b*) the point or points where danger is likely to be met; and (*c*) the tasks which each component part of the force is to perform:

(ii) that a clearer knowledge is necessary generally regarding the use of R.E. and the issue of orders to them:

(iii) that in a situation of this sort plans must not be made too far ahead:

(iv) that a mean must be arrived at between excessive caution and precipitate action:

(v) that it is vitally important to exploit to the full the lull which will inevitably follow the initial struggle, while the enemy is collecting his reserves.

* * * * *

The morning of the third day was spent in the neighbourhood of Nieuport Bains studying the operations of the 1st and 66th Divisions in preparation for the XV Corps offensive.

A visit was paid to the site of the old front-line positions on and around the "Grande Dune" east of the Yser. These had been taken over from the French in 1917 and held by two battalions of the 1st Division, the 2nd Northants and the 2nd K.R.R.C., until the 10th July, when they were driven out with heavy loss after a bombardment described by the Director as the most intense he had ever experienced. Tactically the weakness of such a position was

obvious, and from Colonel Russell-Brown's description of the inadequate defensive works in this sector, it was clear that only with the acquiescence of the Germans could the French have maintained their foothold east of the river. The French had been content to adopt a policy of *laisser faire* which had been reciprocated by the Germans opposed to them, but our arrival betokened an offensive intention, and the Germans took steps to counteract it. In the attack which followed two battalions were virtually wiped out, and the task of the XV Corps greatly magnified.

The strength of the German defences here showed up in marked contrast to the weakness of our own. Over a large area of country, extending back along the coast for some miles, concrete pillboxes, well sited and sturdily constructed, served as shelters for the garrison and as machine-gun emplacements or anti-aircraft gun positions. It is a striking fact that although the Germans contrived to use concrete even in their front-line positions, no attempt seems to have been made by ourselves or the French to use this form of defence, in spite of the difficulty of constructing trenches, breastworks, or dugouts in the running sand. There is a lack of stones for aggregate locally, but the Germans had obviated the difficulty by using broken bricks from demolished houses or concrete blocks brought up from the rear.

After duly examining the remains of the post where the left-hand man of the British Army used to stand, the party re-embussed and proceeded *via* Nieuport across the river to Nieuport Bains to study the situation which faced the C.R.E., 66th Division, in 1917. A commentary was given by Colonel Garforth, who, as O.C. 430 Field Company, had the task of throwing one medium and two light bridges across the river on the night following the XV Corps attack. The river here is tidal with a strong current, and near its mouth the banks are low shelving stretches of sand and mud. Since the war, brick retaining walls have been built up on either bank at the site where the two French bridges used to stand, but sufficient of the original bank could be seen a short distance upstream to enable the conditions obtaining in 1917 to be clearly visualized. "R.B." described the situation as it existed prior to July 10th, and syndicates were asked to discuss possible means whereby, given the use of modern equipment, the bridging situation could have been improved. While this was in progress a report circulated that the Minerva saloon had arrived laden with lunch (and wives), so an adjournment was made to the nearest *estaminet* for the consumption of buns and bock.

Appetites appeased, the party set off after lunch *en route* for Ypres by way of Dixmude and Poelcapelle. A halt was made on the Passchendaele Ridge to visit the ground over which the great battles for the ridge were fought out in 1917. Those who were ready to

face a trudge across ploughed fields to the crest of the ridge were rewarded with an interesting account of the fighting by the Director, who was present with the 1st Division at the later stages of the battle. A further halt was made on the outskirts of Zonnebeke, while Colonel Martin gave his personal recollections of the opening phases of First Ypres, and the Director pointed out the impossible position in which the 28th Division found itself in April, 1915, when Zonnebeke was at the extreme point of a long narrow salient barely three miles wide and in full view of the German positions to the north and south.

After a drive through Potijze, during which those who had served in the Salient looked in vain for any familiar landmarks, the Menin Gate was reached, and the party spent a few minutes in admiration of this truly magnificent memorial to those " Officers and men of the British Army who fell in the Ypres Salient and to whom the fortune of war denied the known and honoured burial given to their comrades in death." The list of R.E. names occupies a prominent position on the inside of the main archway on the north side of the Menin Road.

Tea was taken in Ypres, where the majority dutifully patronized the British Legion Headquarters, the few backsliders going off in search of souvenirs and sticky buns elsewhere in the town.

The itinerary had been planned to include Hill 60, so, after tea, the chars-a-bancs moved off along the Menin Road *en route* for the scene of some of the most desperate fighting of the war. A short halt was made at Hooge crater, where Colonel Playfair and Major Pickering recalled incidents which occurred in June, 1915, when the 14th Division, one of the first of the new " K " Divisions to take part in the fighting, received its baptism of fire : and, from a point near Inverness Copse, Colonel Green described the battles for Sanctuary Wood.

Hill 60 has been wired off, and, except for the memorial to the Queen Victoria's Rifles, remains exactly as it was at the end of the war. The enclosed area includes part of the old British front-line trench and a deep dugout, both in an excellent state of preservation. No " eye-witness " account was forthcoming here, as no member of the party had been present at the battle. One distinguished officer offered to supply a few anecdotes, but he was hastily suppressed when it was ascertained that he had spent the entire war in Egypt and Palestine.

A drive back through Ypres, to catch a glimpse of the canal bank and Essex Farm before dusk, completed the programme, and shortly after 6 the return journey to Middelkerke was begun. As darkness fell a light mist turned to a thick fog which made driving extremely difficult. Thanks to skilful piloting by Colonel Tickell, the large char-a-banc, despite its chauffeur's evident determination to drive

all oncoming traffic off the road, reached the hotel in safety. The small char-a-banc shed a wheel two miles from home, and discharged its passengers into the road to complete the journey on foot. The light saloon car carrying the Director and his staff took a wrong turning and arrived at Middelkerke eventually about 9 o'clock.

To round off an eventful and enjoyable day a small party of enthusiasts, bent on savouring the nocturnal delights of Ostend, chartered a taxi to take them there. The vehicle provided was somewhat decrepit, definitely not up to weight, and capable apparently of one speed only (*circa* 35 m.p.h.). The fog was almost impenetrable, and the driver, having providentially negotiated the first corner, proceeded to deposit the car in the nearest hedge. Having been hauled out and put on the road again by his passengers, he started off, at speed, along the esplanade. After hairbreadth escapes from (*a*) diving over the sea wall, (*b*) climbing the dunes, and (*c*) trying conclusions with a traction engine, the party, their nerves shattered, decided to return, while life remained, to the soberer and less perilous pleasures of the Grand Hotel de la Plage.

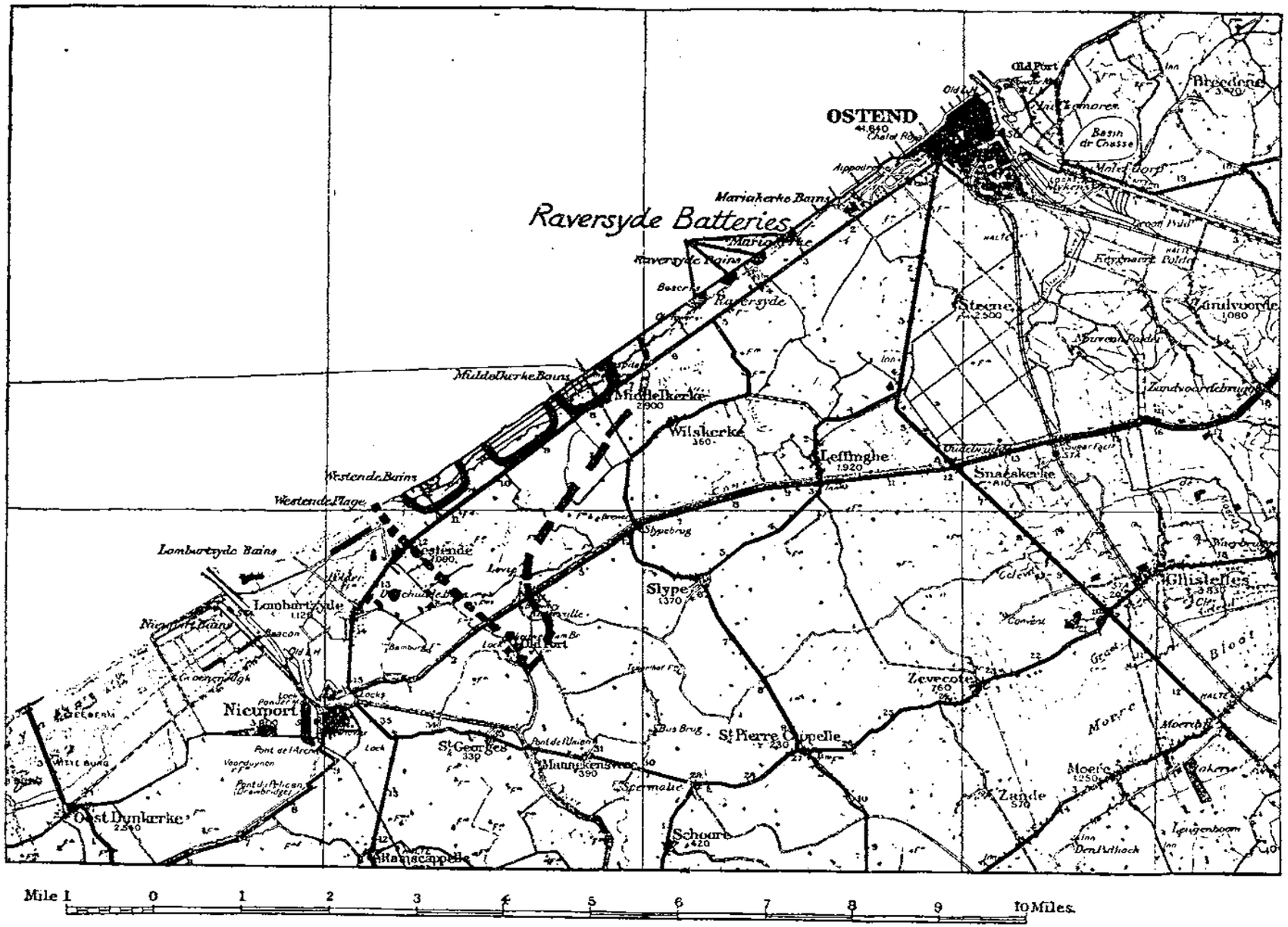
And so ended an instructive and most interesting tour. The fog cleared in time for the return boat to sail as scheduled at 11.15, and the Channel was like a millpond. No difficulty was experienced in smuggling all the souvenirs of the tour through the Customs, and at Dover Station the members of the party dispersed to their various destinations, the Chatham contingent arriving home soon after 4 o'clock.

* * * * *

It may interest those who took part to know that the necktie affected throughout the exercise by our leading Jehu was merely that of his college 2nd XI. The colours of the 1st XI are, we are given to understand, something rather more distinctive.

* * * * *

A STAFF EXERCISE IN BELGIUM.



1st Objective of 1st Div. ——————

2nd " " " " - - - - -

Objective of XV Corps. .....

WINTER SPORTS IN NEW ZEALAND.

By LIEUTENANT W. F. ANDERSON, R.E.

THIS article has a moral. Some good may come from working for a promotion examination. If the writer had not been reading Cole's admirable treatise on imperial military geography, he would never have seen the tempting backbone of mountains in New Zealand labelled 10,000 feet or more. Nor would he have reflected on the beneficent disposition whereby, just at a time when India is at its hottest and most unbearable, New Zealand is in the depth of winter.

After that, it was merely a question of going into ways and means, from which it appeared that with three months' leave from the frontier, plus a few days' station leave in which to join the boat at Bombay, it would be possible to spend five complete weeks in New Zealand itself.

Snow seemed a geographical certainty. But it was only a few days before leaving that the writer succeeded in finding someone who knew definitely that ski-ing was to be had. This was reassuring, especially when arriving at Peshawar railway station on a warm April morning, followed by a sweating coolie carrying skis. Even a member of the Corps sometimes objects to being taken for a lunatic.

The voyage to Auckland or Wellington takes 25 days and is too well known to be worth describing. For anyone who hesitates to spend so much of his leave at sea, it is worth mentioning that, of this time, six days are spent in Australian ports, so there is plenty of interest to break up the voyage. Given a few congenial passengers, the time does not seem to drag.

Both North and South Islands of New Zealand are mountainous, and both hold ski-ing.

North Island is entirely volcanic, and its mountains are all volcanoes, more or less extinct.

Except for Mt. Ngarahoe, there is none that smokes. This, however, is no definite guarantee of safety. In 1886, Mt. Tarawara, previously believed extinct, blew up without warning, wiping out all life within a radius of ten miles. North Island is still so active as far as earthquakes and thermal phenomena are concerned, that it has probably not seen its last eruption yet.

The ski-ing centre is the National Park at Tongariro, close to the volcanoes of Ruapehu, Ngarahoe and Tongariro. Ski-ing is possible

in July and August on all of these, the best being the lower slopes of Ruapehu.

The trouble with Tongariro is that it is not more than 60 miles from the coast in three directions, and has no surrounding ranges of hills to protect it. So periods of thaw and sticky snow are frequent.

The scenery is quite out of the ordinary and very beautiful. The view in late afternoon looking west from the slopes of Ruapehu is not easily forgotten; a rolling sea of purple hills; and Mt. Egmont rising out of them 80 miles or more away, a perfect pale green cone against an orange sky. A visit to Tongariro was well worth it, if only for that. But a would-be skier coming from abroad is unwise to stay here for long, as there is far finer ground in South Island.

South Island has a backbone of mountains running its entire length, steep on the west, and running more gradually on to a plain on the east. Mt. Cook, the highest peak in the country, is almost exactly in the centre of this range, known as the Southern Alps.

The finest ski-ing in New Zealand is to be had on the glaciers east of Mt. Cook. The Hermitage, a large and completely self-contained hotel, almost a village in itself, is the one and only place to choose as a centre, as its management owns huts on all the glaciers in the neighbourhood. The Hermitage is 2,700 feet above sea-level. Although snow may fall there any time between June and October, it does not lie for long. To get good ski-ing it is essential to live in one of the glacier huts.

The largest of these is the hut at the foot of the Ball glacier, lived in permanently by a guide and his wife, and capable of holding about sixty people. This forms an excellent ski-ing headquarters for anyone content with a simple life, a comfortable bunk, good food and plenty of it. Anyone who expects to amuse himself, or be amused, both day and night, might be disappointed.

Winter sports in New Zealand are still in the pioneering stage and perhaps none the less fun for that.

Evening amusements consisted of gramophone and "rummy" (for peppermint points), but this seemed to keep the inhabitants of the hut in pretty good heart.

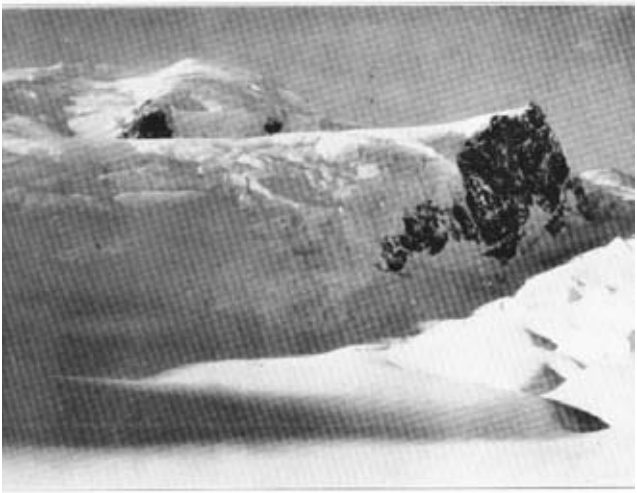
Three weeks in this hut, or others farther up the glacier, seemed to go all too quickly.

An expedition to the Maltebrun Hut was well repaid. A start at dawn; a 3,000-foot climb to the Lindenfeld Saddle; a view of 60 miles west to the Tasman Sea; and a breathless descent of six miles over perfect powder snow; these were the ingredients of a day not soon forgotten.

The run from the Ball Pass is said to be even finer; in June, unfilled crevasses made it impossible.

Height for height, the ski-ing season in the Southern Alps is slightly longer than in Switzerland. The Ball and Tasman glaciers

Photograph 3.—Some peaks of the Southern Alps, from Tasman Saddle.



Photograph 4.—Crevasses on the Tasman Glacier.

Winter sports in New Zealand 3-4

are certain of holding ski-ing between June 1st and November 1st. Spring snow conditions start early in September. The best months are July, August and September.

Ski-ing in New Zealand has developed enormously in the last three years. Every town of any size has its ski club, and the Hermitage holds two meetings in the year for competitions. The quality of ski-ing is probably low by Swiss standards, but the energy and keenness displayed is great, and the skill will not be long in coming.

The New Zealanders are enterprising folk, or they would not be in New Zealand. But to operate a large concern like the Hermitage, 200 miles from the main railway, is a particularly fine effort.

The hotel manager was very keen on getting a team of skiers from India to come out and compete against New Zealand. He promised that if a team of four or more could collect themselves (skill at ski-ing desirable, but by no means essential), he would approach shipping companies and others and see that they got reduced rates.

No one should be deterred from visiting New Zealand by the fact that he has no friends in the country. The New Zealanders are the most delightful and friendly folk, and anyone coming from outside, at any rate if he be British, is made to feel at home at once, and nothing that can be done to help is too much trouble.

In case it may be thought that the cost of three months' leave of this kind is prohibitive, a few details of expenses are given below. They compare favourably with the cost of a three months' shoot in Kashmir.

The writer travelled first class on the boat, had five weeks in New Zealand, covered 1,000 miles during 10 days of sightseeing, and then spent the remaining time ski-ing. He lived (abstemiously) in comfortable hotels, though avoiding the expensive ones.

The cost of the trip, starting and finishing in the Khyber, was £160, made up as follows :—

Cost of getting to the boat and back	..	£20
Boat fare to New Zealand and back	..	£73
Expenses on boat and in ports of call	..	£22
Expenses for 35 days in New Zealand	..	£45

TERMITES IN MALAYA.

By LIEUT.-COLONEL F. G. HYLAND, M.C., R.E., *and* CAPTAIN (S. OF W.) A. WHITE, R.E.

1.—GENERAL REMARKS.

AN American entomologist, a specialist on termites, maintains that these insects are continuously improving and adapting their methods for the attack and reduction of timber structures. He prophesies that, in course of time, this species will constitute a menace to the existence of civilized humanity.

This is probably an exaggerated statement, but it is, at any rate, a fact that, in the case of W.D. property alone in Singapore, the present average wastage due to the ravages of these tiny insects amounts to some £6,000 per annum, or nearly one per cent. of the capital value of the buildings. Obviously, therefore, the termite is to be taken seriously.

Much of the damage is preventable; for, in the past, the fatal error of treating this enemy with contempt has frequently been committed.

There is a prevailing tendency to regard a study of the habits of insects as belonging to the province solely of the naturalist. It cannot be too strongly emphasized that it is as much the duty of the engineer, in the tropics, to study the life history of the termite, as it is that of the doctor to study the mosquito. If this enemy is to be defeated, and his ravages reduced, information as to his tactics and the methods employed in his attacks are the first essential. For it is only on the basis of such information that sound counter-measures can be taken.

These notes were originally compiled for the use of all ranks employed on Works Services in Malaya; as, however, the habits of the termite are similar in all the tropical parts of the globe, it was felt that they might have a wider application and interest, sufficient to justify publication in *The R.E. Journal.*

2.—ENTOMOLOGY.

The name "white ants," by which termites are popularly known, is itself evidence of past misunderstanding, and it is unfortunate that this misleading description should have stuck to these insects; for

termites, speaking generally, are not white, nor are they related to the true ants in structure or life history.

Termites are, however, social insects, and in this respect resemble bees, wasps and ants, especially the latter. Like ants, the majority of the community are unsexed neuters (workers and soldiers), who take upon themselves all the duties of the colony, except that of reproduction; like ants, the life of the colony is centred round one or more sexually developed females (queens). Generically, however, termites are widely separated from ants. They originate from a stock related to the cockroaches, and in the insect family tree are classified in a separate order by themselves—*Isoptera*.

In appearance, termites can always be distinguished from ants by the fact that the abdomen of the latter is joined to the thorax by a thin connecting link, giving the insect a well-defined "wasp waist," while with termites the abdomen is sessile on the thorax, the connecting link or waist being entirely absent.

Termites are the most important of the few animal species that possess an interior economy with the power to assimilate wood, and they live almost exclusively on this material and similar forms of cellulose. Now, wood is among the most resistant and enduring forms of organic substances, and termites are one of the few agencies that break this material down. The role of these insects, in Nature's economic scheme, as scavengers of dead and dying timber is thus of primary economic importance. For, thanks to their activities, in a natural state, much of the capital of life on this earth, which would otherwise be locked up for years, is speedily brought back into the vital circulation. It is only with civilized man that the activities of termites are the reverse of beneficial.

3.—Species.

The number of species of termites known throughout the world is about a thousand, nearly all of which are found only in the tropics. Of these, eighty-one species have been identified to date in the Malay Peninsula. To describe even all the more common of these species would be out of place in these notes and of little purpose to the object in view.

Broadly speaking, termite species, so far as they concern the engineer in Singapore, may be divided into two groups:—

(A) Those that make their nests in the ground.
(B) Those that make their nests in the wood on which they are living.

Many of the species falling under group (A) establish communities which are numbered in hundreds of thousands, or even millions.

They are, therefore, capable of inflicting wholesale damage to houses in a very short time, once they have gained ingress. On the other hand, the fact that group (A) nest in the ground enables buildings to be designed to make ingress difficult. With houses of sound modern design, it should always be possible to prevent the insects gaining a footing provided an efficient system of inspection is in force.

The damage inflicted by species falling under group (B) is far more local, for the nests seldom contain more than a few hundred individuals. As, however, the queen and her consort may reach their intended nesting place by flying, no timber can be isolated from their attentions. Wooden structures in buildings of the most modern design are, therefore, vulnerable, and though a single nest may do little harm, termites of this group may collectively cause very serious damage if permitted to work unchecked.

To the custodian of buildings, the group (A) species are potentially far the most dangerous. It will suffice, therefore, for the present purpose, if a general description of the habits and life history of a typical species of group (A) is given, followed by a few notes on group (B).

4.—LIFE HISTORY—GROUP (A).

(*a*) *Foundation of the Colony.*—The colony is founded by a male and female termite (king and queen). The royal pair excavate a small hole in the ground and the first batch of eggs is laid. The offspring hatch to workers and a few soldiers; they are tended by the parents until they reach maturity—a period of about six months. All the duties of the colony are then taken over by the workers, who enlarge the nest and tend the king and queen. The latter now functions as a vast egg-laying machine, and to do so undergoes an extraordinary post-adult change. Her abdominal segments swell to several times their original size; she becomes some two to three inches long and in appearance resembles a large fat maggot, quite incapable of movement.

(*b*) *Egg-laying.*—The queen lays eggs at the rate of several thousands a day for several years, and as queens have been known to live for as long as fourteen years, their progeny can be reckoned in millions. As soon as the eggs are laid, they are taken charge of by the workers, who clean them and carry them to special nurseries within the nest, where they are tended until the young nymphs hatch and are sufficiently developed to take their allotted place in the community.

(*c*) *Workers.*—The workers form the vast majority of the population of the colony. They are sexually undeveloped and are quite blind. Their function is to build the nest and repair damage: to

forage for and collect food for the whole colony. With many species the workers are found in two sizes, large and small.

(*d*) *Soldiers.*—The soldiers are a specialized caste of workers. They are easily distinguished from the workers proper by their hard, large heads, furnished with large prominent mandibles, capable of giving a painful bite. As with the workers, there are often large and small forms. Their chief function is to defend the nest against enemies, especially against the true ants, which in nature are their chief menace. If a breach is made in the nest fabric, some soldiers immediately rush to the spot and line it with their formidable jaws, until the repairs, which are effected in an incredibly short time, have been completed by the workers.

(*e*) *Sexual Forms.*—The sexual form of termite is the next caste to be considered. These are generally found deep down in the nest and are more elongate in form than the workers. They are the adolescent forms of the future winged males and females—prospective founders of fresh termite communities. The wings appear when they are about half-grown. At certain times of the year, depending on a proper amount of humidity and on a sufficiently high temperature, large numbers of these nymphs arrive at full maturity. As winged adults they remain in the nest for a few days. Then they emerge from the nest in huge swarms and they make a flight of short duration. To gain some idea of the vast fecundity and reproductive capacity of the termite, it is only necessary to witness a swarm of these nymphs in progress from a large nest. A continuous cloud of these winged adults goes up from the nest for an hour or more. The air is filled with flying termites and for long distances round the ground is covered with them. The numbers released must run into five figures at the least. Fortunately, Nature provides vigorous counter-measures. The vast majority fall an easy prey to birds, lizards, ants and other predatory insects, all of whom will be seen to be exceptionally active, feeding on the defenceless termites as soon as a swarm takes place. The few, however, that escape this onslaught, only a fractional percentage, drop to the ground and pair off. They then break off their wings at the base and start to found a colony as already described.

(*f*) *Reproduction.*—Although the nest is started with a single king and queen, the workers are able, by special feeding of selected nymphs, to raise additional royal pairs within the community. Thus in a large nest it is quite common to find two or more royal pairs sharing the royal cell. Moreover, should the queen die, a new locally-raised queen can be substituted. It is well to bear this fact in mind when dealing with a nest. The fact that the existing queen or queens have been destroyed is no guarantee that the workers that have escaped may not be able to raise another queen and renew their

communal activities, although the killing of the queen will reduce their capacity for doing damage for a considerable time. Nothing short of wholesale destruction of the nest will ensure that the colony is not re-established.

(*g*) *Local Species.*—The most common species of group (A) found in Singapore are *Macrotermes gilvus* and *Macrotermes carbonarius*; so far as the engineer is concerned, the habits of these two species are identical. Both attack practically all forms of timber in houses voraciously, and as they live in large communities, the damage they can inflict on buildings in a comparatively short time is very great.

(*h*) *The Nest.*—The nest may sometimes be found at the base of a tree, but more frequently on the open ground. It can be distinguished by a small hillock of earth, six inches to two feet in height, according to the size and age of the colony. Plate I shows a large nest of *Macrotermes gilvus* located at the base of a tree in Tanglin Barracks, Singapore; Plate II a "close-up" of the same nest after a portion has been opened up. Termites cannot exist in water-logged soil and yet must have a certain amount of moisture; it follows that the most favourable site for a nest is on terraces halfway down a slope. A certain amount of experience is required both to know where to look for them and to identify them when found.

The nest is made of finely-divided earth cemented together by a salivary secretion; they are wonderfully designed, for they are so fashioned as to be well ventilated yet weather-proof. On opening up a nest, innumerable galleries will be disclosed; these ramify throughout the whole structure. Deep down in the nest will be found the "royal cell," in which the royal pair or pairs are imprisoned. This is a round, flattish structure, about 3 in. high and 5 in. or more in diameter. On opening this, the cell itself will be found in the middle; the floor is quite smooth and flat and the ceiling is domed to permit of that egg-laying machine, the "queen," resting in comfort, and for the army of attendants to move about freely within. There are many ways of ingress and egress, each guarded by a soldier, but the "king" and "queen," of course, cannot leave the cell.

Plate III illustrates two specimens of royal cells of *Macrotermes gilvus* extracted from different nests. In Plate IV, one of these cells is seen opened up. It contained three queens, three kings and attendant soldiers and workers. The kings are considerably bigger than the soldiers; one may be seen in the photograph between the two lower queens.

Several species of termites, among which is included *Macrotermes gilvus*, are fungus-growers. Situate in various parts of the nest will be found extensive so-called "fungus gardens." These consist of a large number of cells resembling sponges in appearance. In each cell of this spongy material will be seen several small, whitish spheres;

Photo 1.—Nest of Macrotermes Gilvus.

Photo 2.—" Close-up " of opened nest.

Termites in Malaya 1-2.

Photo 3.—Two royal cells.

Photo 4.—A royal cell opened up.

these are fungus bodies used for feeding the young termites. The "gardens" are kept in excellent condition, and it appears that the termites only allow certain kinds of fungi to exist by "weeding" the beds as necessary. In Plate II, several specimens of these fungus gardens are visible.

Spreading out like tendrils from the base of the nest are numerous underground galleries by means of which the workers reach the scenes of their insidious operations; the normal radius of a large nest is 300 to 400 yards.

(*i*) *Feeding.*—Deprived of his sense of sight, the termite worker makes up for this deficiency by the extremely high degree to which it would appear his sense of smell is developed. The distance from which he will sense the presence of suitable food is uncanny. Soft juicy woods, such as pine and spruce, are a special delicacy. The presence of packing cases made of this material is a sure means of inviting attack.

The power of termites to remain alive with little or no food for long periods is a characteristic which the engineer will do well to bear in mind. As with many other social insects, the food economics of a community is a study in itself. Members pass food from one to another by regurgitation, whilst the excreta is eaten again and again till the smallest item of nutriment has been extracted. A termite colony can remain in unimpaired efficiency without apparently receiving any food for several months. Hence the weapon of starvation is a difficult one to impose.

(*j*) *Methods of Work.*—Although blind, the workers are extremely sensitive to light, which they always endeavour to avoid. Foraging expeditions to discover fresh sources of food are carried out in the open by night, but as soon as an objective is discovered, it is connected up by underground galleries or, where this is impossible (*e.g.*, over stone or concrete), by covered ways about ½ in. wide, formed of a thin crust of earth cemented together with saliva. In this manner the operations of the community can be carried on in darkness throughout the 24 hours of the day.

These covered ways, or "trails," as they are commonly termed, are frequently the first indication of the presence of termites. Their appearance is very characteristic and once seen will always be recognized. The insects build them with remarkable speed, frequently several yards in one night.

Although this proclivity for constructing trails probably leads to the early detection of the ground-nesting species more often than any other characteristic, it is, on the other hand, largely due to this avoidance of light that the depredations are so insidious. For the termite, in order to work in darkness, works at the timber from the inside and leaves the surface intact. Thus a 9 in. x 6 in. beam,

which has been attacked, may look as solid as the day it was put in and yet be a mere shell. Similarly, furniture or any other form of timber to which the insects have gained access may, to all outward appearances, appear in perfect condition and yet crumble at the merest touch.

Another feature of termites, of considerable importance to the engineer, is the power possessed by the soldiers of certain species, among them *Gilvus* and *Carbonarius*, to excrete an acid by means of which lime mortar and lime concrete and to a lesser extent metals, may be dissolved. Cases have occurred of termites boring through lime concrete and even lead piping enclosing telephone wires by this method. Sound Portland cement concrete, however, presents a barrier to which the termite has no reply.

5.—LIFE HISTORY—GROUP (B).

Species falling under this group have the same general characteristics as those just described for group (A). The organization of the wood-nesting group is, however, on the whole far inferior, and their social development is on a lower scale. They work in much smaller communities; a nest seldom contains more than a few hundred individuals and their activities are very local. In place of the wonderfully designed and engineered nests of the ground group, we find an irregular ramification of galleries, constituting the nest within the wood which is being eaten. If we compared a nest of group (A) to a highly civilized city, one of group (B) might be compared to a village of aboriginal savages.

Moreover, fortunately, the reproductive capacity of the latter group is much smaller. The belly of the queen does not swell, and her egg-laying capabilities are comparatively small. In some species of this group, there is no worker caste; the immature sexual forms officiate in this capacity.

The presence of a nest of group (B) is frequently indicated by a collection of brown dust in the vicinity, rather similar in appearance to that formed by one of the boring beetles. The dust, however, may be distinguished from that formed by the latter by the fact that, with the termites the brown powder is excreta and, therefore, of a muddy consistency, whilst with the borer the dust is merely wood filings. Occasionally, the same indication may be given by termites of group (A), but as they have connection by their runs to the ground, the local ejection of this excreta is not so likely to occur.

The most common species of group (B) in Singapore is *Calotermes domesticus*, but many other closely allied species will be met with, and their habits, so far as the engineer is concerned, are identical with *Domesticus*.

In addition to the wood-nesting species, instances also frequently occur of a pair of *Macrotermes gilvus*, or similar ground-nesting species, starting their family life in the timber of a building and raising their first batch of eggs in these surroundings. As soon as a few workers have reached maturity, they make for ground and form a nest there on the lines already described, shifting the queen as soon as a place has been prepared for her. Though potentially, therefore, the formation of a nest of the earth-nesting group in the timber of a house is a serious menace, no more damage will be done than by species of the wood-nesting group, provided their initial activities are frustrated.

6.—Curative Methods.

That offence is the surest means of defence is certainly borne out in combating the termite menace—the war must be carried into the enemy's country and his base destroyed.

With the wood-nesting species, such measures are obvious; indeed, the renewal of the damaged timbers automatically achieves the destruction of the nest. With ground-nesting species, however, this is not the case, for the root of the trouble—the nest—may lie in a hillock a hundred yards or more distant from the building attacked. The renewal of the damaged timbers and the destruction of a few thousand termite workers effected in this process, however necessary for structural reasons, is no remedy whatever. Such tactics are comparable with the use of beer and sugar traps to exterminate wasps. For, so long as the colony remains intact, any numerical losses sustained are rapidly replaced by the indefatigable queen and her staff, while the renewal of the eaten timbers merely replenishes their larder. A great deal of money has been wasted in the past through failure to recognize this fact. Indeed, so frequently did renewal work result in ultimate failure that it came to be accepted that a building once infested with termites could not be permanently disinfested. We now know that such is not the case, provided the nests in the surrounding ground can be destroyed. The line fo advance of the termites should be traced out foot by foot until their starting point has been discovered. The nests should be dug up, the royal cell extracted, the queen or queens killed, and the remaining inhabitants destroyed with creosol, paraffin or petrol.

In 1931, an old officer's quarter in Tanglin Barracks, Singapore, had to be vacated as unsafe, owing to the ravages of termites in the roof timbers. The area surrounding the building was submitted to a careful scrutiny and several termite nests destroyed. Owing to the extent of the ravages and the age of the quarter, renovation was not a business proposition, so that no active measures were taken against the insects within the quarter itself. In spite of this, the destruction

of the nests produced an almost complete cessation of the destructive progress of the termites.

Where the location and destruction of the nests is impracticable, the salving of a building which has been attacked has little chance of success. A machine known as an " ant-exterminator " may be used. It consists of a coke or charcoal furnace on which a quantity of a mixture of 75% white arsenic and 25% sulphur is placed. The furnace is connected to an air pump, by means of which a draught is driven through the former to support combustion and drive the poisonous fumes out through a tube. The nozzle of this tube is applied to one of the termite holes and all others are blocked up. The fumes are then forced in for 5 to 15 minutes. A similar method is to place in the runs sawdust mixed with 40% white arsenic. Yet another method is to mix a paste of 50% white arsenic and 50% calomel with water and place this in one of the trails. In the case of vertical trails, an alternative method is to make the mixture more liquid and inject it by means of a common syringe.

Not only do the insects coming in contact with the arsenic die, but other workers and soldiers devour them and are also poisoned. The method, however, is at best a palliative ; it may reduce the teeming millions for a short time, but they are quickly replaced. The use of arsenic in a dwelling-house is always fraught with danger and this method, if used at all, should only be employed in storehouses or other buildings not used for habitation.

7.—PREVENTIVE MEASURES—DESIGN IN NEW CONSTRUCTION.

Prevention is always better than cure ; the importance of designing buildings so that opportunity for attack by termite is reduced to a minimum need not be emphasized.

The first essential is to construct the building on a platform of sound Portland cement concrete, which, as we have seen, forms an impenetrable barrier to the insects. It follows then that any attempt made to gain ingress must be over the edge of this seal, with the result that the trails will be exposed to view. In other words, a termite-proof course in tropical countries is as essential as a damp-proof course in other climes.

The second essential in design is the reduction of timber and all cellulose materials to a minimum. For the less food available for the termite, the less is the inducement to attack. Fortunately, in this age of reinforced concrete, the task is simplified ; the main fabric, including floors and roof, should be constructed of this material, or of brickwork in p.c. mortar. Timber, where used, must, of course, be hardwood ; for, though termites can assimilate all the common woods used in building construction, the softer the wood the greater

is the liability to attack. Teak, though initially expensive, is frequently the cheapest wood to use in the long run.

Experience gained in Singapore has shown that buildings designed on these lines are immune from serious damage from termites, provided an efficient system of inspection is in force.

8.—Preventive Measures—Design in Repairs.

In the case of old buildings designed without consideration of the termite menace, the problem of termite immunity is far more difficult. Indeed, in some instances, the chance of saving the structure, except at a cost out of all proportion to its value, is well-nigh hopeless. Many of the older W.D. buildings in Singapore are built on lime concrete foundations, or brick piers set in lime mortar, through which, as we have seen, the termites are capable of making passages by dissolving the lime. The position of such buildings with regard to termite attack is always precarious, for by the nature of their construction a potential covered line of approach is created through which the insects can work undetected. The permanent cure of the structure, once it has been seriously attacked, is sometimes impracticable; complete reconstruction on modern lines is then the only really economical course to adopt.

The impression must not be obtained from the last statement that the majority of old buildings once attacked cannot be saved. On the other hand, many old buildings which have been the subject of attack can be restored, provided care in designing the renewal of the damaged structure is exercised. Slavish replacement is seldom justified; there is a great scope for ingenuity. Naturally, the new work should be carried out as far as possible in materials other than timber. Where, however, timber must be used, greater facilities for inspection of the structure should be given and the habits of the insects should be studied. A few examples will illustrate what is meant.

In Figs. 1 and 2 are shown two sections of a suspended wooden ground floor which has been damaged by termites. The obvious defects in design are:—

(1) Inaccessibility for inspection and periodical treatment of the underside of the floor.

(2) Lack of light and ventilation beneath the floor.

(3) The maximum amount of timber has been built into the masonry, and no effort has been made to prevent timber being in contact with the walls, the main line of approach of the termites.

Figs. 3 and 4 show the design adopted in replacing this floor. Arched openings in the walls give access to the underside of the floor for inspection and treatment, and at the same time afford light and ventilation ; by the use of iron brackets, the minimum area of timber is in contact with the walls.

Fig. 5 shows a design of roof which, were examples not so frequent in Malaya, might be suspected of having been expressly planned to attract termites. Note the dark box (indicated by a circle) formed by the roof covering, fascia, soffit and beam filling, providing an ideal retreat for the termite to work in undetected ; a haven he only too frequently finds. The built-in wall plate, purlin and junction of the principal rafter with the tie are further undesirable features. To crown all, the lack of head room makes inspection inside a matter of great difficulty, especially at hips and valleys, the most vulnerable points. Figs. 6 and 7 show a design in which these defects are remedied.

Figs. 8 and 9 give an example of a sleeper wall of unsatisfactory design from the point of view of termite immunity. In Figs. 10 and 11 a suggested design of replacement is given.

These are only three examples of many in which thought and ingenuity in design will assist in frustrating further attacks. The following are a few of the common precautions adopted in practice :—

(*a*) Omit ceilings beneath wooden floor joists.

(*b*) Use tile or cement skirtings ; board skirtings are a favourite line of attack.

(*c*) Avoid, as far as possible, contact between timber and walls, and building timber into walls.

(*d*) Avoid wooden thresholds, and use concrete feet under door posts.

(*e*) Never place timber on, or in, the ground. Where this is not possible, char the feet of posts and soak the contact earth in the post hole with creosol.

9.—OTHER PREVENTIVE MEASURES.

Apart from design, the most important protective measure is to keep the ground surrounding all buildings as free as possible from termite nests, thus reducing the liability of buildings to attack, and striking at the root of the evil. A nest of *Gilvus*, or similar ground-nesting species, takes three to four years to reach maturity, so that destruction has a far-reaching effect. In Singapore, the training of one or two native labourers to detect nests has met with outstanding

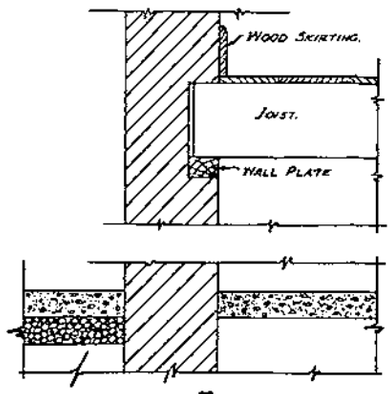


FIG. 1.

EXISTING

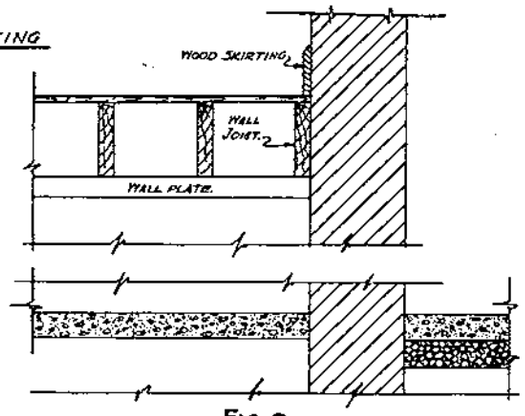


FIG. 2.

AMENDED

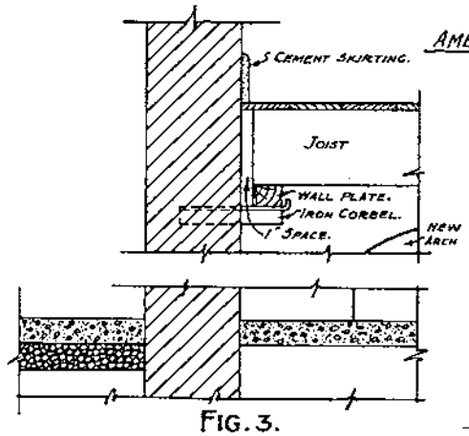


FIG. 3.

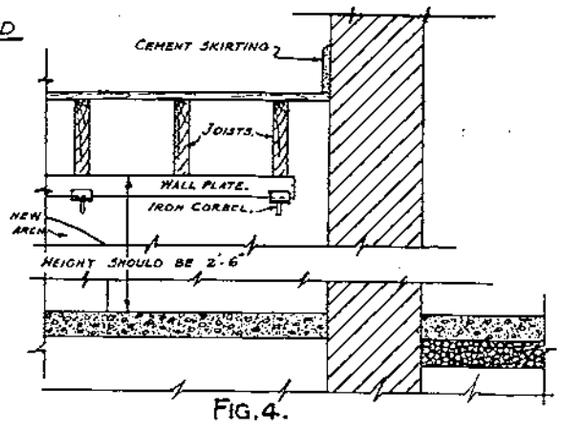


FIG. 4.

EXISTING

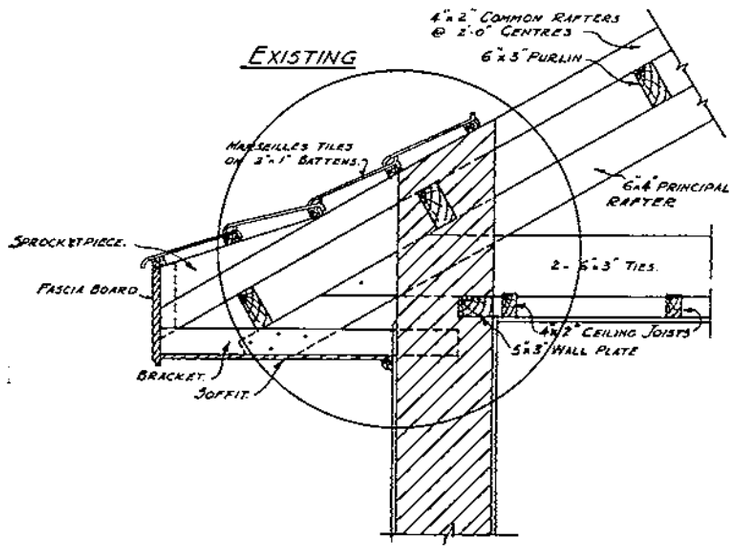


FIG. 5.

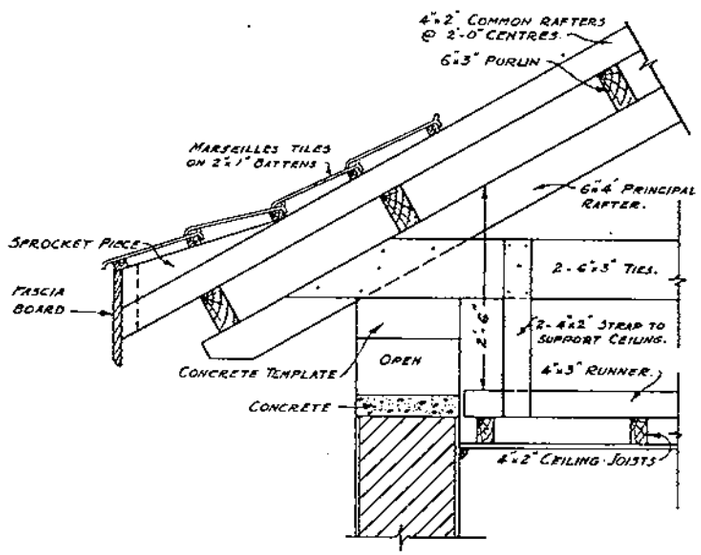


FIG. 6.

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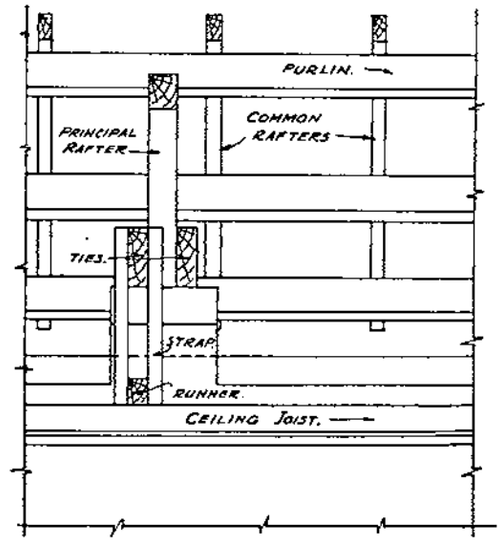

FIG. 7.

EXISTING.

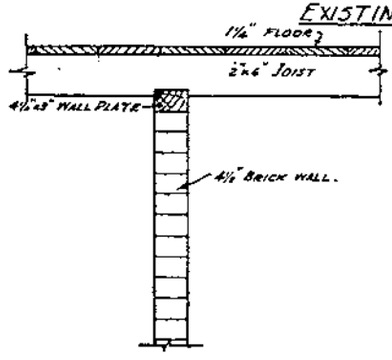

FIG. 8.

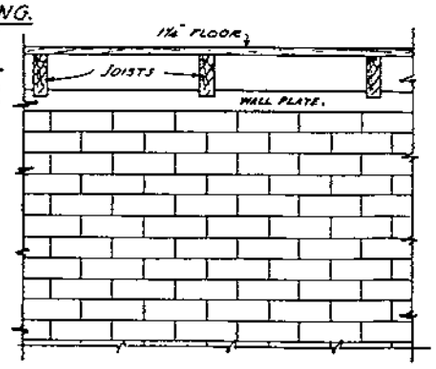

FIG. 9.

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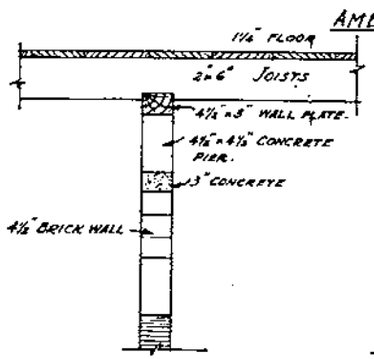


FIG. 10.

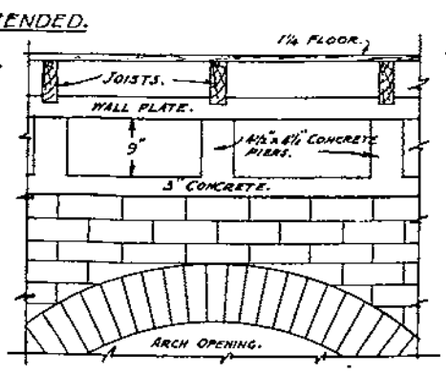


FIG. 11.

success. Tamils and Malays appear to possess aptitude for this kind of work.

The painting of woods with some preservative, acting as a deterrent to termite attack, is an obvious precaution which should always be adopted in all timber construction. Solignum, creosol, sodar oil, or even crude petroleum, are all suitable. Sodar oil is the cheapest but probably the least effective. The use of petroleum and sodar oil should be confined to roof members and other places which do not directly form part of the living accommodation. The effect of any of these preparations is only superficial unless the wood is impregnated under pressure. The expense of this process is, however, seldom justified. Even impregnated wood is only immune from termite attack for a few years. The painting of timber structures with one of the above preservatives should, therefore, be resorted to at frequent intervals; the ends of timbers should be given special attention as the termite normally works along the grain. It must be borne in mind, however, that no amount of preservative will create immunity. Indeed, it is doubtful whether superficial preservatives will seriously reduce the activities of the ground-nesting species in a building to which they have gained access, though creosol may sometimes be used to form a barrier to the further progress of the insects by boring holes in the timber and filling them with preservative until saturation has been reached. Wood preservatives are, however, invaluable in reducing the number of attacks from group (B) species, as it discourages their first entry.

Lastly, no preventive measures are of permanent avail unless accompanied by an efficient system of inspection. Foremen of Works and personnel under them must be trained to identify signs of termite activity. The occupants of buildings should be encouraged to report to the R.E. officer in charge any suspicious signs. Buildings which have been attacked in the past, or which, from the nature of their construction, are specially vulnerable (*e.g.*, those with lime concrete foundations), should be inspected at least once a month; a quarterly inspection of other buildings will suffice.

REPORT ON TUBULAR SCAFFOLDING BRIDGE.

By CAPTAIN O. J. BATTINE, R.E.

(EDITORIAL NOTE.—*The views expressed in this article are not entirely in accordance with the results obtained from other experiments with tubular scaffolding: but attention is called to the fact that 2" and not 3" scaffolding was used in this case, and it is believed that no other bridge on this scale has been built of 2" scaffolding.*)

1.—In 1906, the 48th (S.Midland) Divisional Engineers built a timber trestle bridge over the lake at Clifton Zoo, for use during one of the periodic "Fêtes." Sixpence was charged for entry to the bridge and £200 was taken in a week.

Early in 1933, in connection with a similar "Fête," this unit was again asked to erect a bridge. A 2" tubular scaffolding bridge was suggested by this unit, with a view to experimenting in its use for bridge construction with a fairly large clear span. Only 2" tubular scaffolding was used except for decking and ribands, and this was agreed upon; an estimate of £50 was submitted and approved; the Tubular Scaffolding (Great Britain) Ltd. undertaking to hire the material at a greatly reduced rate.

2.—The design of the bridge was affected by the following considerations:—

(*a*) Wet gap 150 ft. wide.

(*b*) Depth of water: 3 ft. more or less uniform, and thin concrete bottom.

(*c*) Load: pedestrians only. The figures taken were the same as infantry crowded at a check, calculated at 5 cwt. per foot run.

(*d*) A 10-ft. roadway, with a wider platform in the middle for a fortune-teller's booth.

(*e*) Appearance: the bridge must look as neat as possible and lend itself to decoration with "fairy lights," etc.

(*f*) A 6-ft. clearance beneath the centre span as waterway for pleasure gondolas.

3.—The latter factor led to the whole length of the bridge being increased to 188 ft. The original "Forth Bridge," or cantilever

design, had also to be modified in the case of the centre bay, the lower rakers being dispensed with, and the upper ones duplicated, thereby giving a clear waterway under most of the two centre spans. The design was submitted to the Tubular Scaffolding Co.'s expert, the Zoo Fête organizer-in-chief and the City Engineer, but emerged substantially unaltered. (See photographs.)

4.—Rehearsal. (*a*) A specially selected party of volunteers attended H.Q. three evenings in succession, when they built and dismantled two piers and one bay on dry land. In the absence of "shore bays," or any effective counterpoise, the pier towers bent inwards about 6 in. at the top, allowing the bay to sag. The towers did not tip.

(*b*) At week-end camp (Whitsun), the 224th Field Coy. erected a pier tower and launched it in the Avon Kennet Canal at Limpley-Stoke. This process was found to be extremely arduous, particularly as a sort of parapet at the back of the towpath had to be surmounted. It was also found almost impossible to adjust the pier legs to the irregularities of a muddy bottom. Finally, delaunching from the clinging mud was an appalling task.

5.—Bridge construction. The detail of this is shown clearly in the attached work table. To summarize this, it may be said that a party of from 10 to 16 Territorial Sappers worked every evening for 10 days, or about 40 working hours.

6.—Method. Profiting by experience at the canal, it was first attempted to construct a pier *in situ*. The pier was found impossible, in practice, to square up, and it had to be dismantled completely and all the piers built on land. In this connection it is worthy of note that all experience tended to show the extreme difficulty of adjusting this equipment. Contrary to expectations, it invariably paid to dismantle and reconstruct where possible.

7.—Launching. Two methods were employed. First, the pier was built complete, with its wooden feet and rakers on, the latter loose-hinged at the base, and bent up in line with the tower legs. The whole was then carefully lowered, head to lake. It was then found not particularly difficult to prise into position with long tubular scaffolding poles used as levers.

The second method consisted of rafting out on a pontoon raft (1914 model pontoon). The previously-erected tower was carried bodily by hand on to the raft. This took about 16 men to do, and the obsolete raft proved just too small for convenience; the modern raft, affording a better foothold to the carrying party, would have been better.

The raft was then hauled out to the pier site, anchored securely, and the pier raised, some steel tubes being used as launching ways. It was here that some difficulties were experienced, owing to the

couplers catching in the gunwale of the raft, and preventing the descent of the pier. In the event, as the pier was tilted higher, it simply carried away a part of the gunwale and subsided into its correct position. This difficulty could be overcome by using the cut bay road-bearers with the modern pontoon raft. Sliding thus into place on the concrete bottom of the lake, Nos. 2 and 3 piers presented little difficulty. No. 4 pier, however, descended upon an irregularity, a concrete ridge which ran between its legs, causing it to rest on its lowest horizontal member, instead of upon its feet. The difficulty was overcome by a bathing party of P.S.I. who made an accurate survey of the bottom at this point, during the morning, enabling the exactly correct amount of wood-packing to be rapidly placed beneath the feet, when the necessary party were again available. The pier was quickly righted, the only sign being that its top was 4 in. higher than it should have been ; nor was this apparent.

8.—There were no further serious difficulties in construction, and it was found that with a smaller shore pier and a good-sized shore bay, the phenomenon of pier bending inwards and consequent sag did not recur. Some difficulty was experienced in finding room for the couplers of the double rakers on the centre pier, and, even with these, the two centre bays lacked the rigidity of the rest of the bridge.

9.—The bridge successfully carried :—

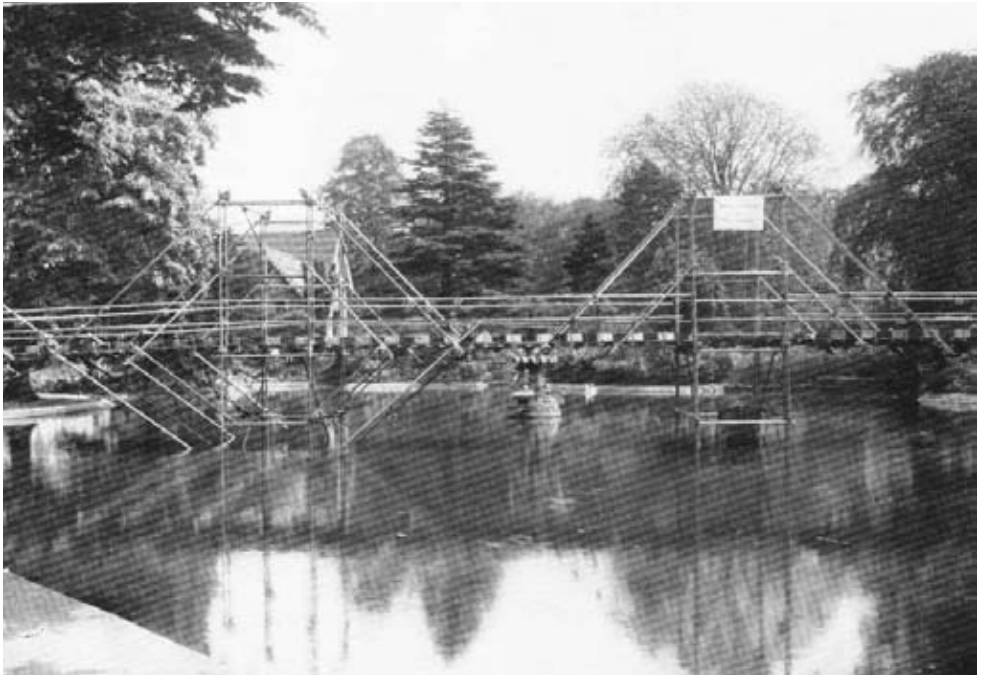
(i) A decorative " pagoda," with its attendant wind pressure.
(ii) Various enthusiasts' motor-cars.
(iii) Crowding to capacity.

10.—Remarks and deductions. On the whole, all were disappointed that the equipment, excellent as scaffolding, was not found more suitable for bridging. The drawbacks were :—

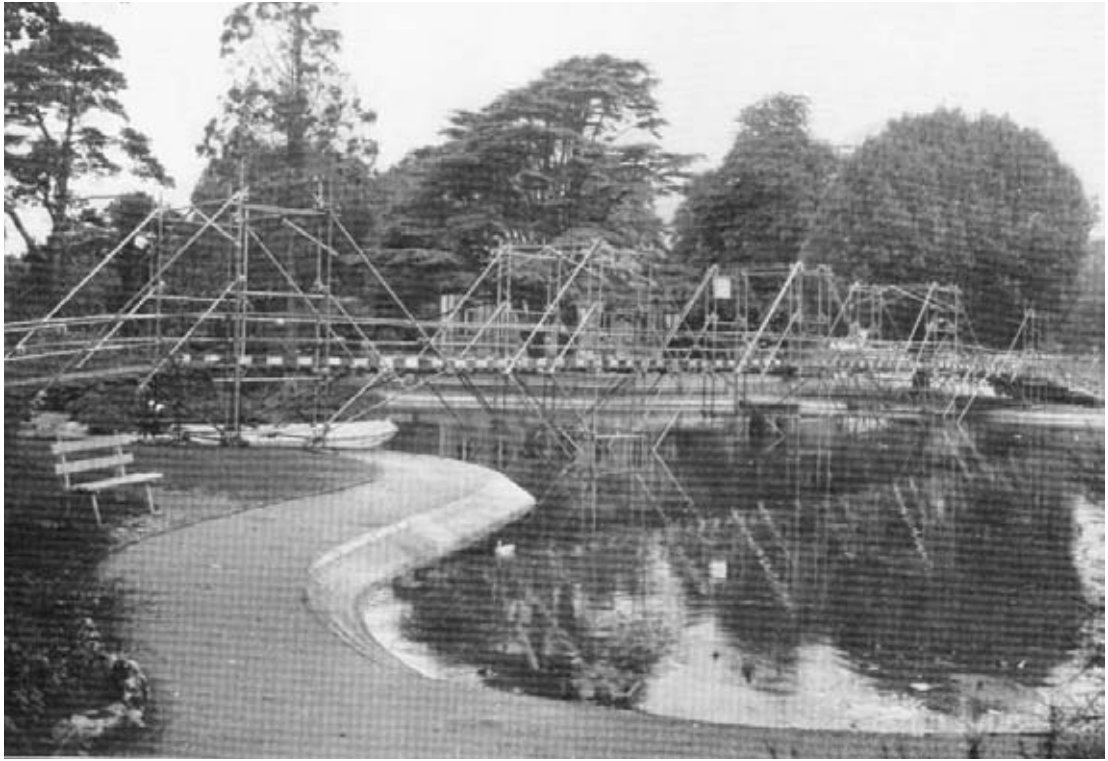
(i) Lack of rigidity.
(ii) Numbers of small parts.
(iii) Difficulty of adjustment.
(iv) General unsuitability to an ordinary wet gap and bed.

Dealing with these in order :—

(1) Rigidity rather than strength is the limiting factor in design. An ordinary tubular scaffolding bridge, designed for strength, if of this size or larger, would be so vulnerable to resonance that any considerable body of infantry crossing it, and failing to break step, would, in the writer's opinion, destroy it. To avoid this, so many redundant members



Report on tubular scaffolding bridge 1.



Report on tubular scaffolding bridge 2.

would be necessary as to nullify any advantages in weight, speed of construction, etc., which it might otherwise possess.

(2) Not more than 6 ft. of steel tube must be unsupported. Consequently a very high number of fixings—actually over 1,000 for 180 ft. of light bridge—was required, each coupler consisting of three parts. This does not make for rapid construction.

(3) Difficulty of adjustment. This may be open to improvement, if the couplers could be readily loosened off so that legs would slide up and down. This, in practice, is surprisingly hard to do.

(4) Owing to the frequent intervals at which horizontal members must exist, it is very difficult to design a tubular scaffolding pier suitable for (*a*) water deeper than 5 ft.; (*b*) a muddy bottom, with irregular settling under the legs; (*c*) an irregular bottom. The difficulty of adjustment and the impossibility of altering the couplers under water add to this. In conclusion, there can be little doubt that, for military purposes, timber is superior if available. If not, the tubular scaffolding can unquestionably take its place.

Stores Used.

Screw plates	1,054
Chairs	858
Couplings	1,084
Butts	226
Base plates	48
Tubing, in feet	4,242 ft.
Chesses	189

A working table is given on the following page.

Date.	Task.	Men. R.E.	Men. Inf.	Hrs.	Man-hours.	Allotment of Labour. 1930 to 2200.	1930. 2200.	1930. 2200.	1100 to 1300.	1330 to 1430.	1430 to 1600.	1930. 2100.	2100 to 2230.	1930 to 2100.	2100 to 2300.	1930 to 2030.	2030 to 2300.	1930 to 2200.	1900 to 2000.	1200 to 1400.	Materials.
7.6.33	Laying out Stores	12		2·5	30	12															Screw plates .. 1084
8.6.33	Construction Centre Pier	12		2·5	30		12														Chairs 858
9.6.33	Launching Centre Pier	14		2·5	35			14													Couplings .. 1084
11.6.33	Construction Pier No. 2	17		2·0	34				17												Butts 226
11.6.33	Launching Pier No. 2	17		1·0	17					17											Base plates .. 48
11.6.33	Construction Pier No. 1	17		1·5	25·5						17										Tubing, in ft. 4242
12.6.33	Construction Pier No. 4	16		2·0	32							16									
12.6.33	Launching Pier No. 4	15		1·5	22·5								15								
13.6.33	Dismantling Pier No. 4	15		1·5	22·5									15							
13.6.33	Construction Pier No. 4	16		2·0	32										16						
14.6.33	Launching Pier No. 4	16		1·0	16											16					
14.6.33	Construction Pier No. 5	13		2·5	32·5												13				
15.6.33	Constructing Roadway	16		2·5	32·5													16			
16.6.33	Adjusting Rakers and Struts	15		0·3	45														15		
17.6.33	Decking and fixing Handrails locking couplings	11		1·2	132															11	

THE BUILDING RESEARCH STATION.

(Referred to hereunder as the B.R.S.)

By CAPTAIN T. GROVE-WHITE, R.E.

NOTE.

THE author is greatly indebted to the Director and his staff for the trouble they took in showing him their work on a visit paid by him to the B.R.S. This article is an attempt to give a brief description of the Station.

OBJECT OF THE B.R.S.

Until recently, building has been a matter of almost pure tradition. The architect, builder or craftsman was taught his job when he was young, and carried out his life's work according to these teachings, with little deviation from them. The methods and materials of building changed very slowly, the experience gained by the father was sufficient guide for the son, and anything new was generally regarded with the greatest suspicion.

But to-day, things are entirely different. New materials and methods have been introduced, and are being introduced, at an ever-increasing rate; and improved methods of transport have given a wider market to materials which formerly could be used only locally. To every builder (using the term in the broader sense) there is, therefore, a wide choice of materials and methods, and he must have sufficient knowledge about them all to be able to pick out those best suited for his purpose. Tradition is now unable to give all the necessary information, and science must be called upon to help.

To fulfil this function the B.R.S. was set up shortly after the war. Its work is carried out by collecting information already available on a subject from all sources possible, such as from technical literature published at home and abroad, from manufacturers, engineers, builders and craftsmen, and sorting this information, and supplementing it as necessary by laboratory and field research.

CONSTITUTION.

The B.R.S. is a branch of the Department of Scientific and Industrial Research and so comes directly under the Privy Council. The Station itself consists of a very fine old country house, situated

about one mile from Garston, which is on the Watford–St. Alban's Road. The Director of the Station is Dr. R. E. Stradling, and the staff consists of engineers, chemists, physicists and librarians with their respective assistants. The total staff numbers about 140, and includes several old Sappers, among whom is the Director himself, who served with the Corps during the war. Dr. Stradling is incidentally also Director of the newly-formed Road Research Board.

CATEGORIES OF WORK DONE.

The work at the Station falls into two main categories :—

(*a*) Carrying out research work to provide information needed by the building trade generally. The results of this work are made known in the Station publications, which are issued by H.M. Stationery Office. The latter will send to anyone free on request a pamphlet entitled *List of Publications of the Department of Scientific and Industrial Research*, which includes all the publications of the B.R.S. This is a most useful catalogue to have for reference in any office connected with building work.

(*b*) Answers to enquiries from firms, individuals, or other Government departments. If this involves specific laboratory work, a fee is charged to cover expenses. This category includes carrying out tests on materials submitted, the manufacturers being permitted to issue copies of the report on these tests with their advertisements.

SOME DETAILS OF THE WORK.

The Station is not divided off into cut-and-dried divisions, but the work is distributed among the library and a number of laboratories, the work of one laboratory sometimes being very closely connected with that of another. The following very brief description of some of the work is shown under heads more or less denoting the laboratory in which it is done.

Library.

Books on building subjects of all countries are to be found here. The leading British and foreign building journals are taken in, and anything likely to be of general interest in any new book or journal is made known in the *Building Science Abstracts*, published monthly. Every member of the library staff can speak one or more foreign languages so that translations can be made from literature in practically any European language. Other publications of the Station are the *Annual Report*, which gives a short description of the work done and results obtained in each laboratory during the year ; *Technical Papers*, which give a very detailed account of any particular research ; *Bulletins*, written for the " practical " man, and giving

a less detailed account of work than the *Technical Papers;* and *Special Reports,* which are simply what their name implies, reports on any particular job. The *Annual Report* is a very comprehensive and useful book to have, and costs only about 3s. 6d.

Testing Shops.

These contain machines of various sizes for testing the strength of specimens in compression and tension, the resistance to wear of surfaces by means of a sand blast and by other methods, and other mechanical properties of materials. The largest testing machine will exert a compressive force of 500 tons, and one of its uses is for testing the compressive strength of partition walls. A section of the wall, about 6 ft. long and 10 ft. high, being built on a trolly, and moved under the machine when the mortar is hard.

Concrete.

The majority of the concrete work is done in a building in which the air is conditioned to keep it at constant temperature and humidity. One of the most interesting jobs being carried out in this laboratory at the moment is a series of tests to discover the effects of sea water on piles constructed of different varieties of concrete, with 1-in. and 2-in. covers of concrete over the reinforcements. One point that has so far been shown very clearly is that at least 2 in. of cover is necessary in sea work to make quite sure of preventing the reinforcement from rusting. Other important research at present being done is investigations on "creep" of concrete, shrinkage stresses in concrete, the comparative properties of concrete composed of different grades of aggregate, stresses in concrete piles, attacks on concrete of certain natural soils and waters, attacks on concrete of fats and grease, and strength of corrugated asbestos cement roofing.

Limes, Sands and Plasters.

The properties of limes, cements, gypsum, puzzolanas and sands in renderings, plastering and mortars are dealt with here. Some of the main problems to be overcome are crazing and cracking of renderings, permeability of renderings, and reliability of hydrates. A specification has been evolved for the latter. Interesting points not always known in connection with mortars for plastering are that for best workability the sand should not be too sharp and can with advantage contain a very small proportion of clay. The small loss of strength in this respect is more than compensated for by improved ease of working. Cement renderings are more liable to crack badly than lime mortar renderings, and very good renderings can often be obtained by a mixture of the two, giving to a certain extent the strength of cement and the plasticity of lime.

Bricks and Terra-cotta.

The main work in this department has been to seek the causes of deterioration of bricks and roofing tiles. Methods of manufacture all over the country have been studied and compared, and ways of testing bricks and tiles for their weathering properties have been devised. It has been discovered that the most common cause of bad weathering properties of bricks is the crystallization of salts near the surface of the bricks, the salts being derived from the bricks themselves, the soil, the rain, or the mortar. A method, on trial at the B.R.S., of comparing the durability of different kinds of bricks, is to plant them, in vertical positions in the soil, with half their lengths buried and half in the air. A brick that will weather badly, and is unsuitable for use below damp-proof course, will probably start to crumble after six winter months. A brick stood in the open with its bottom a few inches in a tray of water will show much the same effects, and this latter method can be applied to roofing tiles. In this connection it must be remembered that bricks from the same works can vary considerably in quality. Much depends on the part of the kiln the brick is burnt in, and slight changes of manufacture may have a considerable effect on the quality. The porosity test and the ring of a brick are not sure guides as to the weathering quality, as they do not show the salt content; but a hard-burnt brick will be more durable than an under-burnt brick made from the same clay. A considerable amount of work has been done on the efflorescence of bricks. One very common cause of efflorescence is the absorption by the bricks of the salts in the cement mortar, and lime mortar does not usually produce this particular form of the trouble.

Breeze, Clinker and Pumice Concretes, and Sand Lime Bricks.

Methods of testing breeze for soundness have been published by the B.R.S. as a result of work in this laboratory. Sand lime bricks have been given the same weathering tests as clay bricks, and in general appear to be as sound as good stocks.

Glazes.

Under this heading comes glazing of terra-cotta, etc. A method adopted for rapid testing of the glaze is to heat the article to 80°C. and dip it into cold water ten times, and then heat it to 120°C. and again dip it into cold water. A good glaze will only show signs of crazing about the third time it is heated up to the 120°C. temperature.

Puzzolanas and Trass.

The original materials were natural products found in Italy and Germany respectively and some other countries; and can be made

artificially by burning clay to about the temperature of a rather under-burnt brick. Scottish oil shale from which the oil has been extracted, and the Indian *surkhi*, have also puzzolanic properties. These substances if mixed with lime will form a hard cement. A mortar made with puzzolana, lime and sand, has a greater strength than lime mortar, and greater plasticity than cement mortar; and makes an excellent mortar for brickwork and rendering. Roman mortar contains puzzolana, which was very often obtained by grinding up earthenware, and this is the secret of its strength. Puzzolana when mixed in a certain proportion with Portland cement will combine with the free lime in the cement, and not only add to the strength of the concrete, but greatly increase its resistance to sea action. This latter property of puzzolana would seem to be of considerable importance. Artificial puzzolanas may shortly be manufactured and marketed in this country.

Permeability of Walls, Waterproofer Paints, Putties and Magnesite Floors.

All these subjects, though somewhat varied in character, are dealt with in one department. The question of the permeability of walls is, of course, extremely important. It has been found that one of the main paths of water penetration through a brick wall is the crack between the mortar and the brick in the perpends. This crack is bound to occur due to the shrinkage of the mortar and to the continual expansion and contraction of the brickwork, and the water is sucked along this crack by capillary action. In this connection it is interesting to note that a porous brick may hinder this percolation by absorbing the water from the crack, and so, under certain circumstances, prove more efficient than a dense brick. The effect of capillary action is often not fully taken into account. An external rendering, apparently sound, may contain a number of minute cracks which will suck in water like a sponge.

Tests are being carried out to determine the value of waterproofers in cement, and waterproofers as applied to brickwork. As regards the former, information at present available seems to show that a high-class concrete or cement rendering is sufficiently impermeable for most purposes, and will not be much improved by waterproofers. Colourless waterproofers as applied to brickwork are not very durable, and appear not to be able to last for more than a year or two. Research on paint is left to the Research Association of British Paint and Varnish Manufacturers, Paint Research Station, Teddington, Middlesex, except for bituminous and some other paints not dealt with by that institution. The causes of paint failure on building materials has been investigated at the B.R.S., and some interesting discoveries made, one of these being that the main cause of paint failure on Portland cement rendering is the attack by

the alkalis plus the free lime in the cement, in the presence of moisture, on the linseed oil in the paint.

Putties have sometimes shown failures on metal sashes, and a means of preventing this is being sought.

Magnesite floors are excellent if well laid, but many cases of failure have occurred through lack of knowledge and insufficient care on the part of the firm doing the job. Advice on this subject is given when requested, and failures in actual practice are investigated.

Asphalt, Roofing Felts, Bitumen and Asphaltic Emulsions.

Causes of failure of these have been analysed, and a " weathering tank " constructed to produce in a few days the effect of several years of weather. The tank subjects the specimen to cycles of heat, ultra-violet light, wetting, freezing and drying. The ultra-violet light of the sun is probably in normal circumstances the greatest destructive agent acting on these materials. A very usual fault in bad asphalt is the presence of too large a percentage of bitumen obtained from oil, and introduced by the manufacturers. There have recently been a number of asphalt roof failures, after only a year or two of laying them, due to this cause. On the other hand, there are examples of good asphalt roofs in excellent condition after half a century and there is no reason why any roof should not last as long as this if the asphalt is properly manufactured and laid.

Slates.

A rapid method of testing slates is to stand a specimen in 20% and 40% sulphuric acid solutions. A bad slate will swell and its laminations come apart after a few days.

Natural Stone.

The effect of weather and impurities in the atmosphere have been studied in great detail. It has been found that in this country the greatest disruptive agents are salts deposited by rain which, as in the case of bricks, crystallize out near the surface of the stone. Acids from the atmosphere also cause decay ; but the action of frost is not, contrary to what is generally believed, a serious factor to take into account. Methods have been and are being evolved for testing quickly the weathering properties of stone ; for instance, a poor sandstone, if immersed in a solution of sulphuric acid, will show signs of crumbling in a day or two.

Cast Stone and Corrosion of Metals in Buildings.

These two subjects, though not very similar, are dealt with by the same assistant. Some common defects of cast stone are crazing of the surface and discoloration at the joints. The cause of the latter is not yet known, and research on this is at present being carried out. A pamphlet has recently been published on the

prevention of corrosion of lead in buildings. Lead is particularly open to attack from cement mortar under certain conditions.

Heating.

A considerable amount of research has been done on this subject, and a small building, representing a typical semi-detached house, has been constructed in which different methods of heating are being tested. The house is steel framed, so that the external walls can be changed if necessary, without pulling down the whole structure. When different methods of heating are being compared, it is necessary to keep the conditions in the room constant. An apparatus has been devised which will adjust the heating of the room, and this instrument is not only sensitive to changes of temperature, but also to the effects of radiation and draughts. It consists of a metal cylinder about 18 in. high and 8 in. in diameter, and painted black outside to absorb radiation, and containing a heating bulb inside to produce a heat corresponding to that generated by the human body. The cylinder surface is kept at a constant temperature corresponding to the skin temperature of a man by a thermostat which regulates the heating. There are numerous other ingenious instruments in use in this department, many of them invented at the Station, used for various purposes, such as taking measurements of heat passing through walls, and measuring the difference of temperature between the air passing over the surface of the wall and the surface of the wall itself. Results of much of the work have been published.

Illumination.

Research on artificial illumination is carried out at the National Physical Laboratory, and the B.R.S. confines itself to daylight illumination, and the orientation of buildings for maximum sunlight. Advice is given to architects on these subjects.

Timber.

All work on this is done at the Forest Products Research Laboratory, and none at the B.R.S. Publications of the F.P.R.L. are included in the *Lists of Publications of the Department of Scientific and Industrial Research.*

Steel Structures Research.

This does not, strictly speaking, come under the B.R.S., although Dr. Stradling is the Executive Officer in charge, and although a considerable amount of the work is carried on at the B.R.S. This research is a joint enterprise, organized by the State and financed partly by the British Steel Work Association. The work is supervised by the Steel Structures Research Committee, which was

appointed in 1929 for a period of five years, with the following terms of reference :—

(*a*) To review present methods and regulations for the design of steel structures, including bridges.

(*b*) To investigate the application of modern theory of structures to the design of steel structures, including bridges and to make recommendations for the translation to practice of such of the results as would appear to lead to more efficient and economical design.

The Chairman of the Committee is Sir Clement D. M. Hindley, and there are representatives on it nominated by the Institution of Civil Engineers. This Committee has already issued one very interesting report (published by the Stationery Office in 1931) and are about to issue their second. Existing practice in steel work all over the world has been investigated, and measurements have been taken of the stresses in the steel of actual buildings. This enables the stresses, as calculated by various methods, to be compared with the actual stresses. The main problem is to discover practical methods, which can be used in a drawing office, of calculating more accurately than at present the stresses in steel structures. This is an extremely difficult problem to be overcome, largely owing to the fact that the joints are only partly rigid (excepting welded structures) and the rigidity varies with the workmanship. But when this problem is overcome, a considerable saving in steel should be the result.

The first report of the Committee contained " recommendations for a code of practice for the use of structural steel in building," and this differs in many respects from existing important codes in use in this country. For instance, wind pressure specified is 15 lb. per square foot in cases where, generally speaking, the L.C.C. specify 30 lb. per square foot—a considerable difference !

POTENTIALITIES OF THE B.R.S.

The B.R.S. started in a small way, but has been growing rapidly, and has now on its staff experts on nearly every kind of building material. The potentiality it possesses for improvement of building practice and spreading of knowledge is extremely great. That it is being made use of by the building industry is shown by the increasing number of enquiries received each year ; but it is doubtful if sufficient advantage is taken of its publications, and the facilities it possesses for testing materials. An enormous amount of money must be wasted through buying inferior qualities. If purchasers insisted, where possible, on manufacturers obtaining a report from the B.R.S. about their goods, then the buyers, the public, and the manufacturers themselves would be better served.

THE MILITARY ENGINEER SERVICES, INDIA.

By CAPTAIN D. HARRISON, R.E.

A SHORT sketch of the organization and activities of the M.E.S. may be of value to officers who are about to join them for the first time. It would be impossible to cover all the ground in an article of this length, so many of the less important points have been omitted. This might be regarded as a letter of introduction, leaving much to be discovered on closer acquaintance.

Those who have had " Works " experience at home will find very different conditions prevailing in the M.E.S. The size of the average Garrison Engineer's charge is geographically equal to a district in England and many are larger. One in particular is some 450 miles from east to west and some 200 miles from north to south. True, its population is probably little over 200,000, but there may be two jobs of work going on 400 miles apart. This dissemination of work over a large area is common to all charges, and with inferior communications is one reason for the admitted fact that the officers of the M.E.S. are generally overworked. Added to that the works expenditure of the M.E.S. averaged over the number of G.E's comes to roughly £30,000 per annum, the maximum being in the neighbourhood of £100,000, and since we work to rupees it follows that the financial side of our activities is a considerable burden. Racial and language differences even in a small district form another large problem, only to be dealt with by experience. Consequently it is probably not far wrong to say that no new entrant to the M.E.S. is really valuable until he has done a year's work.

Apart from these inherent troubles many of the duties performed by the M.E.S. are carried out by other services at home. For example, the M.E.S. do all the quartering work done by the R.A.S.C. in England, together with the provision of furniture, the recovery of rents and of charges for electricity and water. They also do a great deal of work in connection with hirings and lettings of land which is done by Command Land Agents at home. Thus *ab initio* there is considerably more work to be done.

The bulk of the M.E.S. officers are regular R.E. There is a small and diminishing cadre of R.E. (I.A.), another small cadre of M.E.S. British departmental officers (promoted N.C.O's) and an even smaller cadre of Assistant Engineers (promoted civilian subordinates). In

the last class there are at present only three, out of an eventual cadre of eight.

Corresponding to the Foreman of Works at home is the Sub-divisional Officer (S.D.O.). In this we differ from the Railway and P.W.D. organization, where S.D.O's are gazetted officers, and it would probably be an advantage if this grade were renamed, say Sub-Divisional Engineers. The Buildings and Roads (B/R) Branch contains 80 British N.C.O's and 75 Indian civilians of this grade, including both permanent and temporary establishment. S.D.O's in the Electrical and Mechanical (E/M) and Furniture and Stores (F/S) Branches are almost entirely British S.D.O's. The next lower grade is differently named according to the branch of employment, *i.e.*, as an Overseer B/R, a Supervisor F/S, or a Superintendent E/M. The qualifications of the first two are the same, and they are eligible for transfer between branches. These are the lowest grades of the establishment proper, and consist of Indian civilians.

Below the Overseer grade are civilian *mistries*, another misleading term, as the word *mistri* literally means " tradesman," whereas these Indian assistants to the overseers are really foremen and are in many cases apprentices with some degree of technical qualifications. These, and all labour under them, are paid from the estimates of the work on which they are employed on monthly or daily rates of pay.

The clerical and drawing establishment is completely made up of Indian civilians, of widely varying capabilities. Their chief fault is discursiveness, and there is usually a tendency to lose the real point in a mass of irrelevant detail. On the other hand, they do not seem to mind how late they stay in office and on the whole have an amazingly complete knowledge of regulations.

Labour is abundant, and cheap. Tradesmen are plentiful, but the standard is generally low, and any special work usually needs detailed explanation and personal supervision by an officer. Given a pattern they can turn out good work, especially in timber, *e.g.*, furniture.

Materials available vary in quality and price so considerably that it is difficult to compare them with English standards. Possibly on average the quality is poorer and the price higher, the latter chiefly because of carriage charges. Transport is slowly becoming mechanized, but the bulk of it is still done locally by bullock cart, a method admirably suited to the cheerful laziness of its users. Donkey pack is another equally inefficient method.

The organization is simple. Commands have each a Chief Engineer with a staff of S.O's, R.E. The Command is split up into Districts, corresponding to Divisional or Independent Brigade Areas, in which there are C's.R.E. with a staff of one or more A.C's.R.E. The

functions of the C.R.E., apart from his duties as an adviser to the G.O.C., are chiefly those of administration, inspection and advice, although he is classed as an executive officer. Under the C.R.E. are Garrison Engineers whose charges are defined geographically, according to the number of stations in a District, their importance and relative position. The G.E. runs a self-contained show, and has one or more A.G.E's to assist him. His charge is split up into Subdivisions, each under a S.D.O., or a man of the overseer grade according to its importance. Included in the G.E's establishment are E/M and F/S personnel, of grades corresponding to the work he has to do, varying from an A.G.E. to a Supervisor (F/S) or Superintendent (E/M). He is responsible for every phase of M.E.S. activities in his division, but may call for help in E/M matters, given by the A.C.R.E. (E/M) or the I.R.E.M. of the Command. He has considerable technical and financial powers, *e.g.*, a G.E. who is a Captain may sanction detailed estimates up to Rs. 20,000, accept a contract, allot the funds from his bulk grant, and put the work in hand. He can write off unserviceable stores up to Rs. 5,000, purchase Tools and Plant up to Rs. 2,500 and pay all labour from his imprest account. The powers of a G.E. who is a Major are generally double those quoted above.

The preliminary stages of any work follow general engineering practice, selection of site, design, estimate, approval, both administrative and technical, and the grant or guarantee of funds. The execution of the work may be done by direct labour or by contract, normally the latter except in road work. Contractors, with the exception of a very few well-known firms, are in no way comparable to contractors at home. Normally they possess little or no technical knowledge and less idea of organization. Occasionally the contractor's agent may have some technical qualifications, usually he is little better than a gangman. The M.E.S. frequently have to tell the contractor both where to get his materials, and their quantity, to organize his labour, and to interpret for him the working drawings. It will be apparent, therefore, that adequate supervision becomes all important, as moral and financial standards are not always as high as they might be. Unfortunately this can seldom if ever be carried out, partly on account of geographical difficulties but chiefly through the pressure of office work which, in India, tends to assume an undue importance and an incredible volume.

A reorganization of the accounts system has taken place with effect from 1.4.33, and it is too early to forecast the result. Under this system full records of expenditure and liabilities, from which the up-to-date financial position can be ascertained, are kept in S.D.O.'s offices by M.E.S. clerks. These records of expenditure are not subject to audit. The accounts proper are compiled by the Military

Accounts Department in the offices of the Controller for the Command. Every voucher in respect of expenditure, either for cash, or stores, or inter-departmental debit, is allocated to the work concerned by the M.E.S. executive, subjected to local audit by a Unit Accountant working in the G.E.'s office and forwarded after any necessary adjustment to the Controller's office for compilation. Receipt vouchers are similarly treated. An abstract of the accounts up to the end of the month is sent by the Controller to the G.E. by the 15th of the following month, and it is hoped that a broad comparison of this abstract with a similar one prepared from the records kept by S.D.O's will show any gross errors in compilation or allocation. Such errors should, of course, never occur, but no clerk is infallible, and it seems possible that there may be considerable difficulty in tracing the errors which will occur. To provide against this as far as possible, it has been arranged that the S.D.O.'s records and the M.A.D. accounts will be kept in precisely the same form.

A brief word on bibliography would not be out of place. The *Regulations for the M.E.S.*, recently rewritten, should be read as soon as possible. The first four chapters give a fairly complete picture of the system. Chapter IX, "Accounts," is most important. There are, in addition, a series of Technical Handbooks, of which the most important are *Barrack Synopsis*, *M.E.S. Handbook, Vol. I* (*Buildings and General*), and *Technical Instructions of the E.-in-C.* (now under preparation). All G.E.'s offices have, or should have, a complete library, and it is essential that at least a superficial study of the manuals should be made as soon as possible so that one will know where to find information when required. To make an effort to absorb all that is in them would, except for a genius, be a waste of time. It will be found that the clerical and technical staff know them backwards, but unfortunately sometimes interpret them in the same way.

It is possible that the recent reorganization of the M.E.S., which has made the G.E.'s charge much more self-contained, will reduce the volume of office work. Much of it is of a purely routine nature which can, and should, be delegated to subordinates. The use of demand books in every unit or formation is a great help, once the unit has caught on to the idea. Individual demands for repairs, etc., can hardly be avoided, but the G.E.'s office is chiefly a distributing agency in this respect, and it should seldom be necessary for the G.E. to take an active part provided his S.D.O's are up to the mark. A mistake frequently made is the restriction of the powers of a complete grade, *e.g.*, S.D.O's, because of a misapplication or abuse of those powers in one case by one individual. Petty restrictions are found which are almost inexplicable. For example, until recently the G.E. could not sanction any overtime payment of more than ten rupees,

an absurd figure when the extent of his powers in other directions is considered. Such restrictions are slowly being removed.

Every G.E. suffers a considerable amount of irritation from his troubles with audit. There is, fortunately, a distinctly increasing mutual appreciation between the M.E.S. and the M.A.D. The M.E.S., however, still fail sometimes to realize that an auditor is allowed absolutely no discretion in the interpretation of the financial rules. Although an unauthorized stitch in time may save nine later on, a proverb most applicable to engineering work, it must be remembered that the auditor cannot interpret a rule in this sense, no matter how willing he is. Further, it must be remembered that the M.A.D. only took over the M.E.S. accounts in comparatively recent years after the breakdown of the Military Examiner of Accounts method. This was done in a hurry, without men trained in the peculiarities of Engineer accounting, and though every effort is being made to obtain and train a higher standard of accountant it will still take some years to put things right. Meanwhile the M.A.D. struggle to carry out the technical duties of audit, and technical questions asked by a man without technical training can be most annoying. Yet these duties are specifically laid upon them, and Test Audit, the statutory audit performed under the Auditor-General's office, ensures that some attempt at least must be made to carry them out. On the other hand, the M.A.D. sometimes appear not to realize the practical difficulties of the man on the job, nor that time spent on a very minor objection has a direct repercussion in unsound work which could have been avoided by inspection. After all, the Engineer's primary concern is to get the work done as cheaply as is consonant with soundness and efficiency. Much can be achieved by personal liaison between the M.E.S. and M.A.D. superior service officers, but this is difficult to obtain between two very hard-worked services.

Another cause of pressure on the G.E. lies in the comparatively low standard of technical knowledge of S.D.O's and Overseers. Even British S.D.O's have, with a few exceptions, only a superficial knowledge, while it is very rare for an Indian S.D.O. to be able to tackle more than elementary problems, particularly where they are unexpected. The standard is being raised, but the benefits will hardly become apparent until the next generation. Meanwhile, overwork is inevitable, but the degree directly depends on the capacity for organization and the sense of proportion of the individual officer. It is easy to slip into the way of doing too much detail, wasting time on work which the subordinate staff either can do or must be taught to do. Not only does this result in overwork but it leads to a definite loss of efficiency through lack of time for the real job, supervision. Considering the lack of engineering knowledge of

the man below, it should be obvious that the most useful place for the properly trained engineer is out on his work, and that office work must be put in the second place. Properly-laid foundations of a bridge are much more important than any paper-work. Information should never be called for from a lower formation, without first making sure that it is not already available locally. Clerks are apt to adopt this way of saving themselves trouble, and every officer should be on the look-out for it.

The gloomy side of the picture has now been presented in full. It has a bright side as well, so much so that on balance the bright side wins. The work is definitely interesting, and of a very varied character. The man on the spot is given wide powers and full scope for improvements in design. Big jobs are fairly common even in these days of rigid economy. There is a distinct fascination about original construction and in dealing with the many new problems that arise, and even a year's repair and renewal work leaves a comfortable feeling of successful achievement. The R.E. in their varied capacities have left in India many landmarks to be regarded with pride, and even to-day new ones are appearing, particularly on the Frontier. Every R.E. officer must spend some of his time in works, and the M.E.S. offers the most interesting and instructive ground.

Apart from work there are ample facilities for healthy amusement. India is, on the whole, a pleasant country for those who are prepared to give it a fair chance. Overwork is not so bad as to leave no time for recreation, and indeed to allow this to happen could only be regarded as a sign of inefficiency. Once Jack becomes a dull boy his value as an M.E.S. officer is quite halved, so that to take regular advantage of some of the facilities for games or sport available in every station and district is at least as important as any effort to change the habits and practices of the East.

WINTER WORKS FOR FIELD COMPANIES, R.E.

By MAJOR J. SPOTTISWOODE, M.C., R.E.

THERE is some difference of opinion as to whether R.E. winter training should be carried out, where possible, on a divisional basis or independently within the company organization. The protagonists of the latter base their arguments on the advantage of maintaining the company responsibility for training and the fact that more officers are trained in works organization and supervision. On the other hand it cannot, I think, be denied that the objects of trade training or individual training, which are the purpose of our winter period, are very much better served by centralizing on a divisional basis.

The reasons can be very briefly put. Firstly, no one Field Company will ever have good, or even reasonable instructors, in all the trades in which training is required. It is frequently difficult to find them even in three companies. Secondly, it is nearly impossible to keep all trades going concurrently in the small show and it is almost inevitable that at various periods some trades will have to act as labourers for others. Thirdly, much more varied and ambitious work can be successfully undertaken. Fourthly, excessive variations in available numbers of men of a particular trade are damped down.

I propose, therefore, to give a short account of the present organization of the 1st Divisional R.E. Workshops, and of the work done in the past season.

The workshops are run by one of the Company Commanders, assisted by a subaltern from each Company. Actually owing to courses, postings, leave and other inevitable casualties it is normal for several more officers than this to obtain their experience in workshops organization during the season. Furthermore the metal trades are run as a separate show, taking the men of both 1st and 2nd Divisions. In practice, therefore, nearly, or quite, all the subalterns and probably at least two of the Company Commanders will get the opportunity.

We collaborate with the 2nd Division to the extent of taking their plumbers, tinsmiths, and excess bricklayers, while they accept our masons.

The three subalterns in the 1st Divisional Workshops are allotted respectively to Shops, Outside Works, and Stores and Finance.

The Officer in Charge Shops (not to be confused with the Officer

i/c. Workshops, the title given to the Company Commander in charge of the whole show) holds the labour pool and allots men, on request, to the Officer i/c. Outside Works. He receives orders for work from Garrisons Engineers, Officer i/c. Outside Works, companies, and private military customers, etc., and is responsible for passing out jobs as well done in reasonable time.

The shops he has on his charge, each under a N.C.O., are :—

Carpenters (Productive), Carpenters (Instructional), Plumbers and Tinsmiths, Painters, Bricklayers, Concretors, Machine, Blacksmiths, Drawing Office.

The Carpenters' (Productive) Shop takes all Rate I and II men, and a mistake therein is looked on as a matter for censure and warnings that trade rates are easily lost.

The Carpenters' (Instructional) Shop takes Rate III men, and pioneers, mistakes being dealt with by pointing the moral, and kindly encouragement. Useful work is seldom lacking in these two shops.

The plumbers and tinsmiths are not so easy. It is usually difficult to provide useful and varied jobs and a lot of expensive material is expended on purely instructional work. The Local Ordnance Workshops are very kind in taking surplus tinsmiths who are past the elementary stage, and give them more useful training than we can. Although their hours are longer and more inconvenient, men usually ask if they can be sent there—a spirit to be encouraged.

The painters are normally kept busy, especially at the end of the season. It is as well to get a good decorating job or a car to paint, as start for the winter. It has been found that enterprising N.C.O's i/c. Painters' and Plumbers' Shops can obtain good jobs by direct and unofficial contact with Clerks of Works (C.W's.). Once the matter is thus settled the proper channels are easily navigated.

Bricklayers, of course, do not often use the shop except for trade tests, for which suitable jobs cannot be found outside, or to pass the time as profitably as possible during inclement weather. Concretors use it a certain amount for pre-cast work, such as curbs, drying posts, etc.

The Blacksmiths' Shop is only for a couple of men for small jobs which it is not worth while putting out to Metal Trades Shops. In any intervals they sharpen company picks, etc., and make dogs, spikes, or other useful articles for fieldworks training.

The Drawing Office turns out the necessary working drawings for the shops, and is usually kept fairly busy. Three is the normal staff, over which any excess can be easily absorbed by a C.R.E.'s Office to their mutual profit. Instructional, but otherwise useless, work can be created very easily and cheaply to fill any gaps in the work of the normal staff.

The Officer in Charge of Shops is given the senior available serjeant

as a kind of A./Serjt.-Major under the title of N.C.O. i/c. Shops, who is usually quite capable of carrying on efficiently during short absences of the officer. Two clerks, one preferably a fairly senior N.C.O., and a runner complete the office staff.

This officer's main difficulty is to keep an even supply of work, and especially to finish up the season cleanly without either an appreciable " carry over " of jobs which have to be finished somehow, or else an idle last week. He has to contend with a constantly varying labour supply owing to the demand of outside works, which usually have priority, and sudden withdrawals of men by companies for normal casualties. After Christmas the numbers usually drop considerably. What with checking up work, keeping an eye on tools, arranging trade tests, etc., he has little enough time for his normal company work.

The Officer i/c. Outside Jobs is in a position of a contractor's representative in his dealings with G.E's, with whom the great bulk of his work is conducted. He has in many ways a simpler job than the O. i/c. Shops, since his labour problems are easier. He takes what he wants for the jobs given him, and returns the rest to the shops. Bricklayers, whom the shops cannot normally employ, can usually be found a job, even if it is only pointing, of which any G.E. can usually produce an indefinite quantity. On the other hand, he cannot so easily dispose of work not quite up to standard, watched as he is by eagle-eyed and not always too forbearing C.W's on the look-out for wasted material. He is also much more likely to come up against the heart-breaking job that will not get finished.

It has been found very useful to provide him with a pushful N.C.O. to act as intermediary between the various small jobs (of which we usually have four or five, besides work of a respectable size) and the various C.W's.

The Officer i/c. Stores and Finance is responsible for all stock-keeping and ordering of stores, for the accounts and for completing estimates from the data of materials and time supplied to him by N.C.O's i/c. Shops. These estimates should always be accepted by the customer before the job is started, and are made out on the basis of cost of material plus half the trade pay of the men employed. This works out, on the average, about as much as the market will bear. He is also concerned with the sending out of bills and reminders.

He also runs the transport, of which each company sends one G.S. wagon daily, unless he informs them of different requirements.

He has to keep two quite separate and distinct stocks of material, instructional and private. Material for the third class of work, public, is delivered direct to the job in accurate quantities on A.F.B. 108 of the C.W. from R.E. Stores.

Instructional stock is bought out of a grant of, normally, about £150 allotted by the C.R.E. in his Works capacity, and is used

on instructional work, which as far as possible is production which cannot be paid for from public or private funds, *e.g.*, hand carts, moveable huts for offices for outside works, and so on. A proportion of it has, however, to be entirely unproductively spent, *e.g.*, plumbers' lead for practice joints. The grant is administered by a G.E. on its financial side, but the O. i/c. Stores and Finance naturally keeps close track of its expenditure.

Private stock is purchased direct in the open market, mainly through three firms, who have tendered prices and discount at beginning of the season for timber, paint and ironmongery.

The Officer i/c. Stores is responsible for handing out serviceable tools and not taking back any in an unwarrantably unserviceable state. He puts through the charges for lost and damaged tools, which are charged at full vocabulary rates except in special cases. He is given a senior N.C.O. (probably the hardest worked individual in the shops) and two storemen.

The duties of the N.C.O's i/c. Shops and Jobs lie pretty obviously in the realms of discipline, instruction, organization and supervision of tools, and do not require any further comments.

Every job is put through on a job card. This starts out from the office attached to a working drawing, and goes to the N.C.O. i/c. Shops. He allots to the workman, who makes out his estimate of stores, which is checked by the N.C.O. This may, of course, have already been done in preparing an estimate of cost. The man then draws the materials from the stores, where all necessary details of the job are taken, and the stores issued entered on the card. The job is then carried out and details of hours taken entered up as it proceeds. On completion the whole job is costed and compared with the estimate by the Stores and Finance staff, who send out the bill if applicable. The card then returns to the office for the appropriate records to be taken.

Each man has an employment card, kept by the N.C.O. under which he happens to be at the time, which shows the record of attendance, reasons of absences, and the work in which he has been employed. Short reports on his character and capabilities are added and the card is forwarded to his unit at the end of the season.

The actual average numbers of men employed in the season 1932/33 were :—

Adminst. N.C.O's ..	12	Draughtsmen & Surveyors	8
Carpenters	53	Plumbers..	5
Bricklayers	11	Concretors	5
Painters	7	Others	6

We also trained infantrymen for pioneers, as carpenters 6, painters

4, plumbers 1, and bricklayers 1, all of whom got their 3rd-class Rate.

The value of contract rates of the work done, including cost of material, was, at very conservative estimates:—

Public	.. ..	£2,246 10s. 2d.
Instructional	..	£148 5s. 3½d., plus £36 of material used to waste.
Private	..	£92 10s. 2½d.

The average daily number of men not employed at their trade, excluding those for whose trade we do not cater, was about 4.

The basic idea to which we pay great attention is to impress on the individual sapper that his first care, as a tradesman, should be his tools. Since the tools concerned are not his own, and he does not make his living by them, this is seldom appreciated by the lower-class tradesman, but, by insisting on regular and frequent inspection by the N.C.O's and rigorous charging for lost or misused tools we have of late considerably raised the standard.

Further points that require particular attention and emphasis are accuracy to dimensions and working to drawings, while squareness is too frequently not up to standard. Commonsense in regard to economy of material and weight in selecting sizes of timber is not always exercised, nor is the importance of a neat and workmanlike finish generally appreciated.

We aim at 6½ hours a day on the work, which, added to the sappers' normal military duties, is quite enough. Friday afternoon is given to recreational training, and Saturdays to military training.

There are, of course, few places where the divisional system is possible, but I consider that it is, in its practicable working, far superior to the single company basis, and where, as at Aldershot, company competition is nothing if not fierce, I do not think the company spirit or training suffers in any way.

ROADMAKING BY HAND METHODS, USING AN ASPHALTIC EMULSION.

By LIEUT.-COLONEL J. B. DUNBAR, R.C.E.

IN *The R.E. Journal* for December, 1932, there appeared an article by Brig.-General E. G. Wace on the use of bitumen emulsion for mix-in-place methods of roadmaking. Shortly after the appearance of this article, the Canadian Government decided to open at Valcartier, P.Q., a concentration camp for about 1,700 single unemployed, homeless men. This decision was in accordance with the general policy of establishing such camps at various places in Canada and having them administered by the Department of National Defence.

The men at these concentration camps are provided with food, clothing and lodging, and are given an allowance of 20 cents per day pocket money, and, in return for this, are required to carry out the work that is planned at each camp. Those on the supervisory staffs of the camps are paid allowances at higher rates than those of the men; these allowances vary with the various degrees of responsibility. It is not to be expected that the daily output of work by the men should be as large as if ordinary wages were paid them.

One requirement at Valcartier was the construction of permanent dust-proof roadways within the camp limits, and, in accordance with the policy decided upon for all works, the use of machinery was to be kept to a minimum and hand labour employed to the greatest extent. Another governing factor was that all costs, including material used in all works, must not exceed the sum of $1.00 per head per day.

As a result of reading General Wace's article enquiries were made, and it was found that it was very probable that good results would be obtained at Valcartier by using " Terolas " as a binder for the aggregate available on the spot. This " Terolas " is an emulsion of asphalt and is produced in Canada by " Colas Roads Ltd.," a subsidiary of Royal Dutch Shell.

The soil at Valcartier is composed largely of sand covered by a thin mossy sod. There is hardly any stone or gravel in this sand, but certain deposits of gravel do exist in widely separated areas.

The first road construction decided upon was about 1,600 lineal yards of 20-ft. pavement and about 1,400 lineal yards of 16-ft. pavement, made up of a 3-in. consolidated course and a $\frac{3}{4}$-in. armour coat.

Before any construction was commenced, an old petrol tank car was secured and buried in the ground near one of the railway sidings; the idea was that, when the first tank car of "Terolas" should arrive, its contents would flow by gravity into the buried car, so avoiding any charges for demurrage. From the buried car the "Terolas" was pumped as required into a 500-gallon overhead tank so that the liquid would flow by gravity into transporting wagons. Two old, civilian type horse-drawn sprinkling wagons were obtained, and these were slightly altered in order to transport the "Terolas" to the site of the work. Iron-bound wooden screeds were made and an old hand-drawn iron garden roller was found; the weight of this roller was increased to 400 lb. by the use of concrete. To give the final rolling a large wooden cylinder 5 ft. 6 in. in diameter was built, covered with sheet iron, and weighted by four tons of concrete; double-ended shafts were made for it with crossbars arranged so that from 27 to 54 men could push and pull it over the roadway, the larger number of men being used on grades. The Provincial Government provided a steam-driven stone-crushing plant. Waste wood was used as fuel.

The roads were first surveyed, staked and de-sodded, an allowance being made for a 3-ft. shoulder on each side, and the grades were determined so as to balance cut and fill. The camber allowed was $\frac{1}{4}$ in. per foot for half the width of the roadway. Forms for the sides of the consolidated or base-course were old 4-in. water-pipes taken from a condemned water-line.

To make one batch of mixture, 43 lb. of "Terolas" was weighed into a large bucket hung from a beam scale; then the minimum amount of water was added so that when this mixture was shovelled with the aggregate the solids became thoroughly coated without there being any excess fluid. The average amount of water necessary with the aggregate available at Valcartier was 30 lb. per batch. Each batch was made up of three wheelbarrow loads of this mixture of "Terolas," water, and the material excavated from the shoulders; the result was $6\frac{3}{4}$ cubic feet to one batch and four batches per cubic yard. Each batch supplied material for the construction of the base of $13\frac{1}{2}$ in. of 20-ft. roadway, and the amount of "Terolas" in one batch worked out to $1\frac{3}{4}$ gallons per square yard of a 3-in. base-course. Mixing was carried out by hand on 8 ft. x 6 ft. platforms; each of these mixing boards having a crew of 8 men working at a daily task of 40 batches. This mixing by hand proved to be comparatively severe physical labour, for the material "hung" to a shovel in a similar manner to newly-mixed concrete.

After mixing was completed, the material was wheeled in barrows to either one of two steel sheets, then it was shovelled on to the sub-grade and spread by hand rakes to approximately $\frac{1}{2}$ in. more than the final thickness and to the correct camber. After this was done, the wooden screeds were brought into use, followed as closely as possible by the small roller which was drawn to and fro by ropes from both sides of the road. Immediately following the small roller, the large roller was used to give final finish to the base-course.

On the base-course being completed in this manner, it was allowed to dry for a few hours until it could be walked upon. On regular highway construction, where it is necessary to maintain uninterrupted traffic, "Standard Colas" would have been used for the armour coat, but, at Valcartier, where it was possible to close the road to traffic, "Terolas" was used to avoid the necessity of double storage of emulsion. In applying the armour coat "Terolas" was sprayed on the surface at a rate of $\frac{1}{4}$ gallon per square yard and covered immediately with $\frac{3}{4}$ in. crushed gravel in sufficient quantity to fill any slight depressions and to provide a one-stone thickness. This course was well rolled and broom-dragged to obtain a smooth surface. Then more "Terolas" was applied at the rate of $\frac{1}{4}$ gallon per square yard and covered with $\frac{1}{2}$ in. crushed gravel at approximately 20 lb. per square yard; then this was rolled.

Owing to the limiting factors of the use of hand methods and improvised plant, and as the men were paid only pocket money instead of ordinary wages, progress in building these roads was not fast, but an average rate of construction was 555·5 sq. yds. of 20 ft. finished road per day, and the cost per sq. yd. worked out to $0.3937.

DRAINAGE OF A SECTION OF THE TRENCH AREA: FRANCE, 1915–16.

By W. G. PERROTT, ESQ., B.E., A.M.I.C.E., *etc.*

THE section of the front between Picantin and Boisgrenier south of Armentières in the early days of the war was peculiarly subject to flooding, with the result that many of the communication trenches and excavated defence works could not be used during the winter months. To get to the support or the front line, which were of sandbag breastwork construction an average of 6 ft. high, troops had frequently to cross the open, thus incurring casualties, also the losses resulting from the saturated condition of things were serious.

To try and remedy the difficult situation in the winter of 1914–15, expert advice was sought and pumps were installed at various points, but they had no appreciable effect in improving things. The writer had been sent by the Corps to the area in question in October, 1915, to look after the maintenance of forward roads and to try and deal with the question of flooding if it became serious. At that time there was nothing to indicate that there could be such a thing as flooding in the sector. Everything was bone dry, so much so that troops were accommodated in the bed of the small River Laies, which had its origin in the neighbourhood of Neuve Chapelle, and after entering the British front near Petillon ran along more or less parallel to the front to its junction with the River Lys at Armentières.

As the Laies appeared to be the chief water course in the area, all obstructions in it were removed before rain began, and other channels were cleared as far as possible.

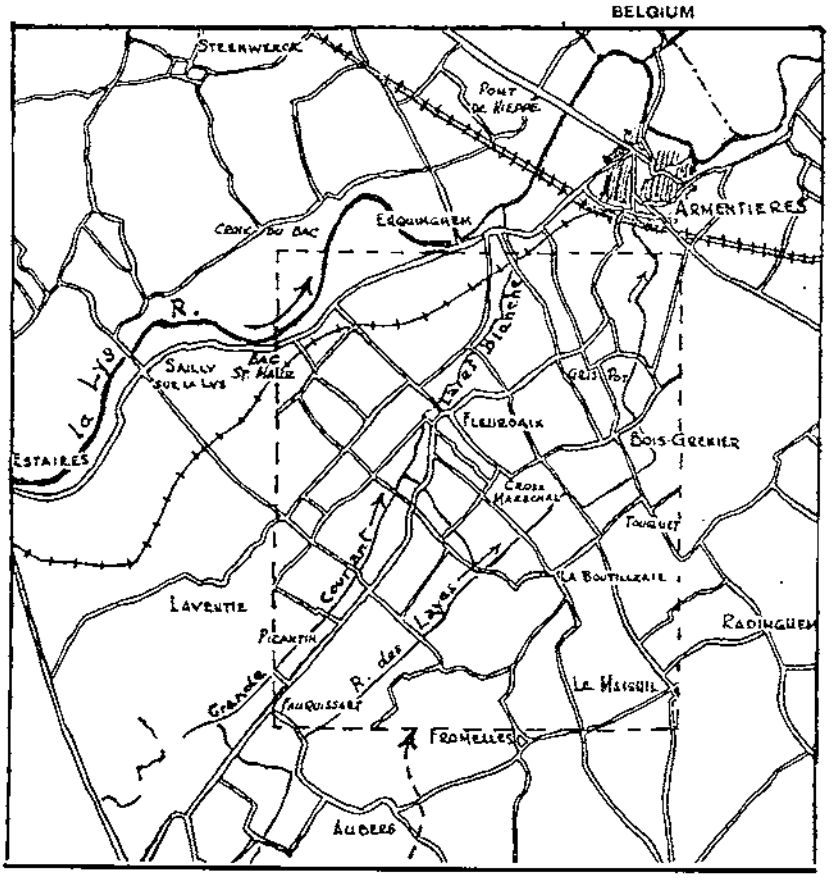
Rain commenced in November, and ere long one understood why the area had such an evil reputation. Every one of the sixteen communication trenches leading to the supports and front lines was flooded to depths up to three feet over the duckboards. A number of the roads leading to the trenches were under water, even many of the fields were flooded. All ditches were choked by growth of long grass, rushes and weeds, or otherwise blocked by the effects of shell-fire. Many small streams running from the German line across No Man's Land and through our front poured into the Laies, but though it received such a large volume of water there was hardly any increase in the velocity of its current. It seemed capable only of rising.

Altogether at this time, December, 1915, things looked pretty

hopeless, but it was just then that a very slight flow in a channel near the village of Fleurbaix gave the idea of the steps to be taken to solve the problem, and a section being taken showed that the nearest point of the Laies was three feet above this channel at Fleurbaix, there being just one and a half miles between the two

Map A.

FRANCE.—ARMENTIERES AREA.



AREA COVERED BY MAP B.

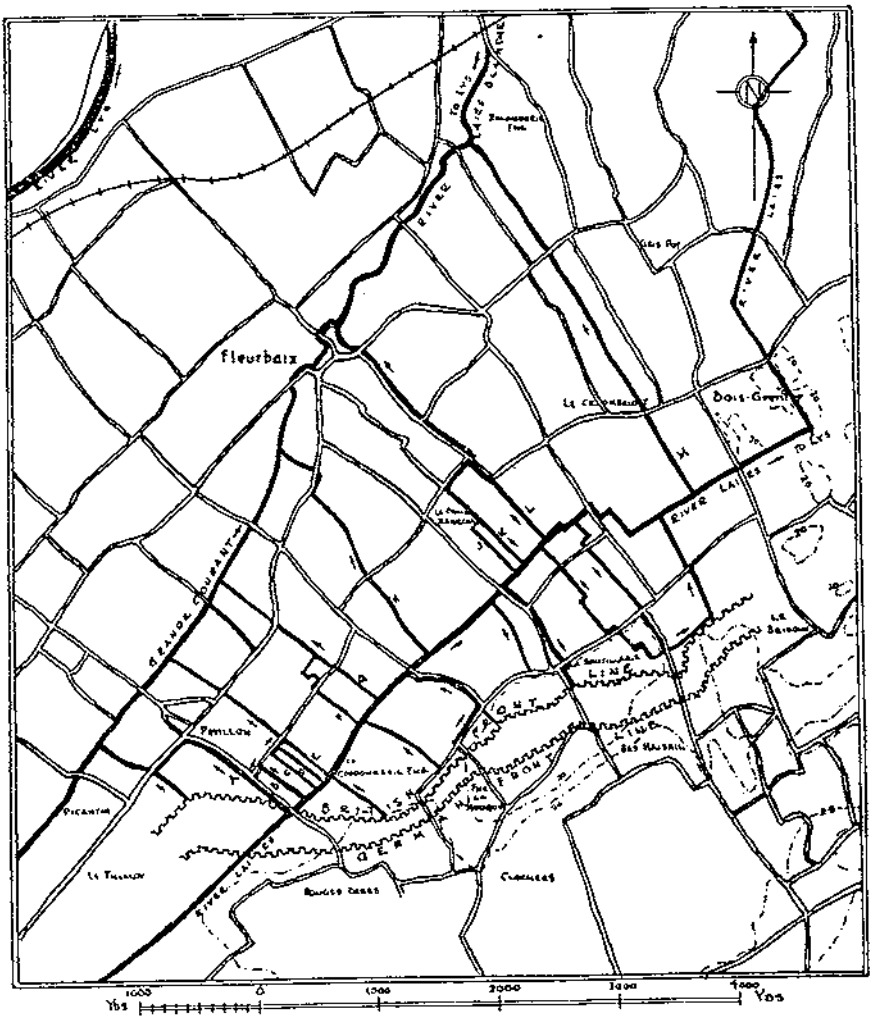
points. Authority was obtained for the employment of a large number of French and Belgian civilians in thoroughly clearing and deepening this channel to its junction with the Laies Blanche, which emptied into the River Lys near Erquinghem, and also in clearing and enlarging the same channel in the other direction towards the trenches.

From the point beyond which civilians would not be allowed to work, a new channel, 10 ft. by 5 ft. deep, was continued forward by a

detachment of the Pioneers of the Division holding that sector to a junction with the Laies. This, marked "L" on map "B," the first of a number of diversion channels, lowered the level of the Laies

Map. B.

DRAINAGE MAP AREA.—PETILLON–FLEURBAIX-BOIS GRENIER.



(on the nearest gauge which was 500 yd. above its point of junction) by nine inches in four hours.

The other main diversions into the Laies Blanche or its tributary, the Grandé Courant, marked by letters on map "B," were then taken in hand, and when completed during 1916 had the satisfactory effect of preventing the Laies from rising to within three feet of its previous high level and saved the trenches from further flooding, at

least till mid-1917, when the writer was transferred to another sector.

The work done by the Pioneers of the various divisions that came into the area, and by one or two Land Drainage Companies R.E., in excavating and grading was admirable. Altogether some 35 miles of channels were cut or cleared and graded, including those for draining roads, battery positions, etc. For want of space, only the more important drainage channels are shown on map "B."

Constant patrolling of all works was necessary as, the available fall being so slight, any obstruction had far-reaching effects. Shell-fire was the chief cause of trouble. Any water resting in hollows under the duckboards of the trenches was got rid of by cross-drains running to the nearest field ditch, which was cleared and graded to an outlet.

The level of the Laies being lowered, many drains were cut discharging into it from the ground behind the front line and also from the support line. The cutting of the diversion channels led to some peculiar results. Whilst there was a slow flow along the bottom of the Laies to its outlet in the Lys at Armentières, the surface water and some two-thirds of its depth flowed in the contrary direction for considerable distances below the junctions of the various diversions.

Some ten or twelve small streams ran across No Man's Land from the German into the British lines. By raising the levels of the sills where they entered our parapet, the water was backed up to the extent of flooding the German front line, as was revealed by air photographs. Theory alone would hardly have led to the possibility of flooding a line at a higher level by troops holding a lower one.

The importance of someone familiar with the whole drainage system being kept permanently in the area, was demonstrated by the fact that newly-arrived divisions would otherwise have endeavoured to convert main-drainage channels into trenches complete with revetting frames and duckboards, and would also have probably interfered with the proper functioning of drains and ditches when laying fresh belts of wire.

It was after the drainage work had been completed that a knowledge of the cause of most of the trouble was obtained from French sources. It appeared that, some eighty years before the war, the course of the River Laies had been altered for a length of two or three miles, so as very nearly to follow a contour and thus act as a great reservoir for water storage during a portion, at any rate, of the dry season. This was the part that caused most of the trouble.

The advantage the writer had over others who may previously have been engaged on this matter, was that he was left in the area to study the problem and to find a solution.

MASS BLASTING ON THE UPPER YANGTZE.

By H. R. DIXON, M.C., B.SC.

(*Consulting Engineer to the K'ung Ling T'an Improvement Commission.*)

(Reprinted from *The China Journal*, May, 1933.)

INTRODUCTION.

THE author of the following article is Captain H. R. Dixon, M.C., R.E. (tempy.). He was commissioned as a Tunnelling Officer in France in 1915, and became Adjutant of 255th Tunnelling Coy. He was transferred in 1916 to the office of the Inspector of Mines at G.H.Q. as Assistant Inspector, for the purpose of compiling the records of the work of the Tunnelling Companies, 1916–1918.

R.N.H.

The following astonishingly modest account of an engineering undertaking that is worthy of the best traditions of the profession will appeal to all who are interested in engineering enterprise in China. We claim to have a small share in it, for last autumn Mr. Dixon, who had conceived the idea of getting rid of the two offending rocks in the always dangerous K'ung Ling T'an Rapids in the Yangtze Gorges above Ichang by blowing them bodily out of the water, came to us for information regarding the geological formation at this point in the river, this being an important matter, since it was feared that, if the material of the adjacent precipitous cliffs was of a crumbling or friable nature, the terrific explosion required to blast away the two rocks in the river might bring the cliffs themselves down as well, and so produce an even more serious condition in the river than that which already existed. We were able to place Mr. Dixon on the right track to secure the necessary information, which he did through Dr. J. S. Lee, Director of the National Research Institute of Geology of the Academia Sinica at Nanking.

Mr. Dixon says nothing of the dangers to which those who carried out the undertaking were exposed, but these will be appreciated when it is realized that the two rocks disposed of lie in the middle of a swirling rapid, making any boat work extremely hazardous, and also that thousands of pounds of high explosive had to be handled by the party.

The mishandling of a single stick of dynamite would have meant the death of every member.

It will be of interest to many of our readers to know that the River Inspector mentioned in the narrative is none other than R. G. Everest, one of the heroes of the Zeebrugge raid and the Jutland naval engagement during the World War.—EDITOR, *The China Journal.*

TRAVELLERS on the Upper Yangtze well know the special dangers of the K'ung Ling T'an Rapid at low level. There are a North and a South Channel at this point in the Great River, and squarely in the middle of the South Channel two large rocks protruded above the low-level surface, making this channel utterly impossible for navigation except during high-water season. During the low-water season, all shipping on the Upper Yangtze had to take the North Channel, and the majority of accidents and wrecks occurred at this point. Some two years ago, leading merchants and shipping interests in Chungking and Whanhsien formed a special Commission for the improvement of the channel at this point, which lies some thirty-three miles west of Ichang, below the Nin Kan Ma Fei Gorge.

The collection of funds and the direction of all technical work was placed in the hands of the Chinese Maritime Customs. Preliminary work was carried out in the winter of 1931–2, and, although a high river-level prevented very much from being done, this enabled the River Inspector to make a thorough study of the possibilities, which formed the basis of the successful operations carried out during the past winter and spring.

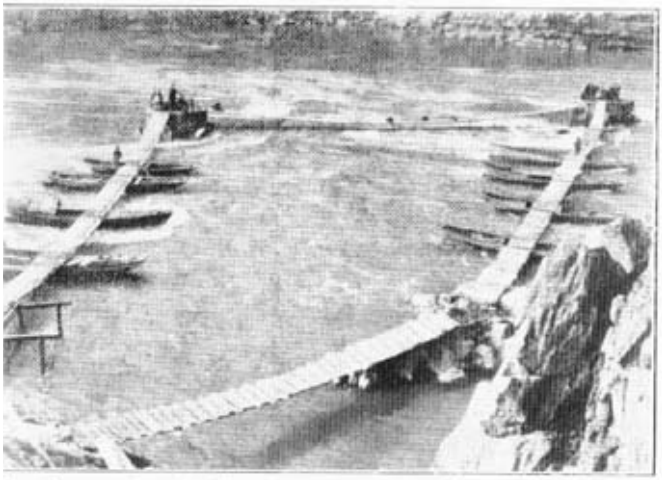
After a further thorough investigation had been carried out in December last, it was decided to attempt to create an entirely new channel for shipping by removing the two large rocks in the hitherto very dangerous and quite unnavigable passage to the south of the great rock called Ta Chu, which divides the river at this point.

The extremely thorough organization of the River Inspector and his staff enabled the objective to be achieved, for, whereas it had at first been expected that only one of the two rocks could be attacked during a single low-water season, not only was that one destroyed completely, but the greater part of the second rock was also removed. By some freak of nature a small portion of the second rock remained below water, but it is, nevertheless, now possible for ships to avoid the tortuous and highly dangerous North Channel.

The new South Channel has a minimum width of 200 feet, in which there is nowhere less than 18 feet of water at local zero-level, while the boils and running whirlpools which made it impassable before, not to mention those at the eastern entrance of the North Channel, have almost entirely disappeared.

The method suggested to the Customs Authorities and subsequently approved by them for the removal of the rocks was that of

The two rocks in the South Channel of K'ung Ling T'an Rapid that made navigation impossible during low water. This picture was taken just before the explosion took place.



low the two rocks at the K'ung Ling T'an Rapid were reached. Note the swirl and force of the water, which rendered operations both difficult and hazardous.

Mass blasting on the Upper Yangtze.

mass blasting, and, on March 22nd, the large charges, previously placed in chambers at the bottom of short shafts made in the rocks, were fired simultaneously.

Sixteen thousand two hundred pounds of high explosive were used for this purpose, and in the resulting explosion some 10,000 tons of rock were scattered completely, some of it to a distance of 1,200 yards.

Throughout the whole of the operations not a single man came to any harm, either from accident or serious sickness. The safety of all the local inhabitants was ensured by their removal to a distance of nearly two miles on the day of the blast. Neither was any damage caused to the cliffs in the gorge above. A few houses were hit by flying stones, but all claims were promptly dealt with to the owner's satisfaction.

The work called for unusual methods in many respects. The construction of sampan bridge approaches to the rocks in the swirling seven-knot current, the erection of reinforced concrete " ships " on the rocks to protect the mine shafts from being flooded out by a rise in river-level, and the shaft-sinking and tunnelling work itself, carried out with very reliable Ingersoll-Rand pneumatic plant, all presented special difficulties, and it was only by unceasing efforts during every minute of daylight that the work was accomplished before the river rose.

The party lived in huts, erected on Ta Chu, during the whole winter, and perhaps the secret of the success achieved lay in the spirit of enthusiastic and happy co-operation which inspired every member throughout.

On March 28th the Customs ship *Hsia Kuang* passed through the new channel three times under the command of the River Inspector, and the first new channel ever made for ships on the Upper River was thereupon declared open.

TACHYMETRIC TRAVERSES.

By COLONEL SIR GORDON HEARN, *Kt.*, C.I.E., D.S.O.

I HAVE read with the greatest interest the note on this subject by Lieut. R. E. Bagnall-Wild, in the June, 1933, issue of *The R.E. Journal*.

I have used the tacheometer for railway surveying since 1900, and have employed all the alternative methods mentioned. I have even used, in rapid railway reconnaissance, a method of photographic surveying.

Survey with a plane-table and a tacheo alidade might have been added. In comparatively open country fixation of position by intersection and of height by tangential calculation may be useful, provided that the distant stations can be identified positively from two plane-table stations, not an easy matter in the wild country on the North-West Frontier of India. Resection may be important also.

Subtense methods may be speedy, and it would be interesting to have a note on this method, as employed in Palestine.

Speed, however, is not the only consideration in railway survey. The engineer must have time in which to reconnoitre for a solution of the many problems which confront him. Again, it is possible that the skilled observer may become incapacitated, while his salary may be larger than the combined salaries of semi-skilled observers, able at a pinch to take on any kind of work with simple instruments.

With regard to instruments, I prefer the vertical circle to be graduated with the zeros on the horizontal diameter. This avoids chance of mistake in subtracting from 90 degrees, when using some tables. I have never found it necessary to use a staff longer than the usual 14-foot telescopic levelling staff.

With these preliminary observations, I pass to the technics of tacheo work, with special reference to the simplification of reduction.

Lieut. Bagnall-Wild mentions *Jordan's Tables* only, but there are others. It may be of interest to the novice to know how these tables affect the system of observation, and to what extent they eliminate the labour of reduction. When equipping a party and ordering tables from a distant bookseller, one may not get exactly what one wants.

It should not be overlooked that, after obtaining horizontal distance and height differences from tables, a further reduction is necessary for level at the staff station. To the reduced level of the ground (not peg) at the instrument station, we add height of instrument. To this result we add, or from this result we subtract, height difference. From this result we subtract reading of axial wire.

So far as I am aware, only in the *Railway Engineer's Fieldbook*,

or in books on surveying subsequently edited by me, has labour in this reduction been saved by the system of setting the axial wire on height of instrument.

This limits the length of shot to about 900 feet, or less if we are using a plane-table, but in a long practice 800 feet has proved sufficient normally. Where obstacles or distance make this impracticable, the axial wire reading must be raised, naturally.

We can still simplify calculation, and avoid labour, by raising the reading by one or more whole feet above height of instrument. It might seem easier to set the axial wire on an even foot, but then we retain a more difficult calculation to obtain the reduced level of the staff station.

To set the (apparent) lower stadia wire on an even foot facilitates the calculation of the generating number from the staff intercept, but this is at the disadvantage mentioned.

Jordan's Tables, published in 1908, are best suited for metric calculation. They give, for generating numbers 10 to 100, height differences for angles 0 deg. to 29 deg. 57 min., rising by 3 min. Next, for numbers 101 to 174 the angles are 0 deg. to 19 deg. 58 min., rising by 2 min., and, lastly, for numbers 175 to 250 the angles are 0 deg. to 9 deg. 59 min., rising by 1 min. For calculating distance the differences of angle are much greater, 20 min. or more.

Reger, in 1910, extended these tables, giving height differences for numbers 10 to 101 for angles 30 deg. to 44 deg. 57 min., with rises of 3 min., and for numbers 251 to 350 for angles 0 deg. to 9 deg. 59 min., with rises of 1 min. Again, large differences of angle for distance calculation appear.

If we have a generating number of 431, this lies outside the limits of these tables. We have to split the number, look up both parts, and make additions. Moreover, especially at the steeper angles, there may be a suspicion that interpolation for the correct angle might give a better result. I am speaking of more accurate survey, but in this there is more labour of reduction, with numerous staff stations.

Louis and Caunt's Tables were published in 1919. These give numbers 1 to 10 only, although the range of angle is by 1 min. rise to 30 deg. For an intercept of 431, we have to take ten times 10, ten times 3 and the figures for 1, and add all together, being careful to set them down in their right places. In the end we shall probably reject the last three figures in the decimal. The waste labour and strain are considerable.

The turning over of pages in itself is laborious, while mistakes in adding up are not readily noticeable without a laborious check. Three tables and a diagram (pages 60 to 66) in the *Railway Engineer's Fieldbook* are just as effective, more so because the angle is taken up to 45 deg.

Redmond's Tables, published in 1931, require a special method of observation. It is necessary to set the vernier on an angle, which is a multiple of 20 min., although, with more labour, it may be set on a 10 min. mark. Thus, for angles up to 20 deg., only 60 angles are used for the " argument " instead of 1,200. Generating numbers up to 850 are given, each angle given requiring 4 pages or 240 in all. A second table extends the range of angle to 29 deg. 40 min. and up to 900 generating number, but involves two or three additions. A third table is for the 10 min. angles, also involving addition.

To my mind, none of these tables is satisfactory in reducing labour. On the Khyber Railway the tacheo was employed over traverses aggregating 50 miles, for the most part in the most difficult country imaginable, and accuracy was essential. I devised some diagrams, subsequently published as *Tacheographs*, by Thacker Spink & Co., Calcutta. They may be seen in the Library of the Institution of Civil Engineers.

There are three diagrams. One gives the actual deduction from generating number to arrive at horizontal distance, thus saving some figuring. The other two diagrams give height differences, more accurately for the smaller angles along the traverse itself. The maximum generating number is 800, but experience had taught me that it is unnecessary to give such high numbers in normal work for the steeper angles. Thus for 24 deg. on the distance graph the maximum number is 180. The height diagrams give differences up to 27 deg. for numbers up to 400.

After all these years, I cannot remember if these limits of angle were ever exceeded. In the Ali Masjid gorge they could easily have been surpassed, but the instrument was set up on a pinnacle of rock across the narrow valley. One instrument station thus sufficed for a large number of staff stations at moderate angles of sight. Any case of excessive angle, not covered by the diagrams, could be solved by the *Railway Engineer's Fieldbook* tables mentioned.

An occasional length of generating number not provided for can be solved by splitting the number into two parts, equal or unequal.

There is another diagram by Gillman, which is not so effective, but is much easier to acquire, I believe. I endeavoured in vain to get booksellers and instrument-makers in England to stock the tacheographs. I learnt that engineers never buy diagrams! Some may yet be so unorthodox as to give them a trial.*

These tacheographs can be used with any of the methods of observation mentioned. Naturally the scale does not admit of results much closer than half a foot, but spot levels do not demand more. On the Khyber Railway the predicted longitudinal section, from paper location, was entirely corroborated by the levelled section, after actual location.

* They are stocked by W. Thacker & Co., 2, Creed Lane, E.C.4. Price, 5 shillings.

THE LIGHTER SIDE OF LIFE IN INDIA.

By COLONEL F. C. MOLESWORTH.

THE call in the March, 1933, *Supplement* for examples of official but unintentional humour caused the writer to search his memory for incidents which have livened the tedium of service in India.

Official publications have, as in the cases quoted in the *Supplement*, contributed thereto. A *Manual of Bush Fighting*, now obsolete, began its classification of the kinds of enemy likely to be encountered by the statement that " certain jungle tribes build their villages at the tops of inaccessible mountains." Rawalpindi Station orders once contained the notice: " There has been an outbreak of rabies in the cantonment: parents and owners of cats and dogs are hereby warned." What seemed a most unfeeling sentence, if its context were not studied, once adorned *Military Engineering*, Vol. III, " Dogs, when heated red-hot, can be twisted so that their teeth make any angle with each other, usually a right angle." While a very true remark once prefaced an official treatise on the use of explosives, " Most accidents occur through reading the precautions after instead of before the accident," but in this case the humour may not have been unconscious.

A senior officer in Mesopotamia received a wound from a bullet which remained lodged in his body. The casualty list in due course announced, " Lt.-Gen. G . . . ., slightly wounded." The officer went to hospital, where the doctors made an incision to try and discover the bullet, which they failed to do. It is presumed that they did not refer to this incision when they amended the casualty list to read, " Lt.-Gen. G . . . , for ' slightly wounded ' read ' severely wounded.' "

While on the subject of doctors in Mesopotamia, the war diary of the Sanitary Officer, Basra, deserves notice. He was directed to produce a war diary, although he pointed out that such a compilation could contain nothing of military importance. But the authorities were insistent, and so the officer submitted the following :—

May 1. Caught 5 rats.
" 2. " 4 "
" 3. " 6 "

and so on.

Another war diary, that of a Scottish battalion on service, as received and printed in India, contained the following entry for a

Sunday: "Divine Service was held by the Rev. Dr. . . . . No casualties."

An officer, landing in India for the first time, found orders at Karachi posting him to Ghora Dhaka, a minute hot-weather station in the Murree hills. The Embarkation Officer could not tell him where it was, and so sent for his chief clerk, a B.O.R. The latter promptly gave his verdict, "There's no such place, sir." "Oh!" said the Embarkation Officer. "What makes you think that?" "Because I've never heard of it, sir," came the conclusive reply.

It is strange how survivals of bygone days remain in regulations. For instance, Rawalpindi Station standing orders to this day contain a prohibition to ride elephants along the Mall, although elephants disappeared thirty years ago from the army, and it must have been many decades since officers could afford elephants as hacks. An *Indian Army Regulation*, which persisted into post-war times, allowed British soldiers, should they be so inclined, to marry *free* negresses; the original of this order must have appeared in the days of slavery and the importation of Africans.

An ordnance officer on a district staff found the date of his assuming his appointment misprinted 1026 instead of 1926, whereupon he submitted a pay claim for 900 years' back pay, amounting to about £750,000. The Paymaster entered into the spirit of the jest, and returned the claim, pointing out that it was one *pie* (the third of a farthing) in error, and requested its resubmission. The correspondence was then circulated round the district office. The Divisional Transport Officer came forward with a generous offer of transport to convey the treasure from the Treasury; the medical branch feared the effect of the sudden acquisition of so much wealth on the officer's health; while Q. remarked that there had been an unexplained loss of ordnance stores after the battle of Bannockburn, and suggested that, as the officer seemed to have been in the English army at the time, the balance of his pay should be held over until the question was satisfactorily settled.

The adherence of Indian clerks to the letter rather than to the spirit of regulations sometimes leads to strange results, sometimes amusing, but often, when pay warrants have to be interpreted, distinctly annoying. One officer ended a long correspondence with the pay authorities by a minute, "Now I understand the dictionary definition of a soldier—'A man who has to fight for his pay.'" The writer once received a memo: "Owing to the *increased* rates of pay sanctioned by *Army Instruction, India*, No. . . . , please refund the sum of Rs. 10.5.6." The italics are mine.

A temporary R.E. officer during the war had occasion to cut up a number of logs into scantlings; the wastage inevitable to the process was queried by Accounts, whereupon the officer replied, "This is owing to the regrettable habit of the Forest Department of growing

trees round instead of square ; their attention has been called to the objectionable practice."

The Great War produced a large amount of unrest along the N.W. Frontier. One of the results was the burning by tribesmen of a levy post called Warai, in which happened to be stored two tape-measures, the property of Government. Application for the write-off was made to the necessary authority, explaining that the loss was due to the burning of Warai post. In due time the document was returned with the remark, " Please quote authority for the burning of Warai post." The officer addressed, after a good laugh, passed on the letter to his clerical staff for disposal ; presently a draft was submitted for his approval, " Sanction for the burning of Warai post has not yet been obtained, but is being applied for."

During H.R.H. The Prince of Wales' visit, one of the leading English papers in Northern India headed a paragraph as follows :—

TAXILA NEWS.

Preparations for Prince's Visit.

Dacoits Kill Four Villagers.

During a smallpox epidemic in an English town, the same paper, in its summary of home news, recorded the item : " Reassuring news about the smallpox epidemic has been received from Gloucester ; the public vaccinator is among the victims."

Letters from Indians, written in the unfamiliar medium of English, still supply unconscious humour. For instance, a clerk petitioning for a rise of pay, gave as one of his reasons his " large family, which was increasing daily." Another described himself at the foot of a similar request as " Your prolific worm." A servant once wrote to the writer stating that " my services to you during the past two years can be better imagined than described." The story of " Tiger jumping about platform, please wire instructions," is well known, but a variant may be quoted where a stationmaster wired to head-quarters, " Tiger roars daily in neighbouring forest, causing great annoyance ; kindly arrange with local gentry to make him his pray."

The Indian members of a senior officer's staff wished to give the latter's daughter a wedding present, and a neatly-typed document was drawn up as follows : " We, the undermentioned members of your father's office, have much pleasure in presenting you with gift as per margin." In the margin were the words " Two silver bowels."

A touching devotion to duty was shown by a member of the same office who sent an excuse for his absence : " I regret I am unable to attend office to-day as I am suffering from smallpox. I will try to come to-morrow."

Telegraph officials all the world over come into contact with

strange addresses, but one placed in the box at Rawalpindi railway station for such telegrams is remarkable: "Muhammad Khan who is searching for wife c/o Stationmaster, Rawalpindi."

Mention of Rawalpindi station leads on to a story of an incident which occurred there not later than the 'nineties, when the platform was cleared by four uproarious and not too-sober Tommies, who charged from one end to the other with fixed bayonets. The station-master, at his wits' end, appealed to two quiet, unarmed men sitting beside their kit-bags on one of the station seats. The request for help met with a curt refusal, accompanied by the explanation, "Beg pardon, sir, we're lunatics and them's our escort."

Indian servants are responsible for many amusing as well as many annoying incidents. At Aden, water is a precious commodity; washing water, the source of which is some tanks reputed to have been built by King Solomon, used to be carried to officers' quarters by camel. One officer's servant made a good thing out of this by selling his master's used bath water to the camelman for the camel's consumption. One day the officer heard a terrific altercation going on outside, and going out to discover the cause, found that the camelman was demanding his money back; the officer had recently taken to using phenyle in his bath, which the camel had refused to drink, although he apparently relished the previous flavour of soap.

A servant will generally couple a request for leave with a statement that a near relative is dead or dying. One lady employed, as is the custom, a tailor to work in her verandah. The man's applications for leave, on the ground of the deaths of near relatives, grew so frequent that at last the lady remonstrated and took down, to his dictation, a list of all his kin, on the occasion of whose death he would require leave. The list was a long one—brothers, sisters, uncles, cousins—and the tailor several times came back with supplementary items. But at last the list was complete, and the process of deletion began, and one by one the names were struck off. At last the man announced the death of his sole surviving relative, and asked for leave, whereupon the lady reminded him that once he was disposed of, no pretext for leave would remain. The man disappeared, presently returning to say that he had decided that his uncle was not dead. Throughout the whole of the proceedings the man evinced not the smallest sign of appreciation of the joke.

More dramatic was the excuse sent by a washerman, by the mouth of his brother, during the influenza epidemic of 1918, viz., that he was dead. He was discovered walking in the street a few days later, and in answer to the remark that he had not remained dead very long, he could only raise a disarming smile, and appeared the next day with a bouquet to resume his duties.

The writing of characters for discharged servants is often a case for ingenuity, for a bad one, however truthful, is naturally never

displayed once the recipient has had it translated in the *bazar*. A dismissed groom once returned to his late master's house at dead of night, and pasted an unsatisfactory character on the coach-house door. An ingenious officer, wishing to warn all and sundry against his discharged bearer, wrote him a *chit*, "If you want a reliable, honest, clean and hard-working servant, give this man a wide berth."

It is extraordinary how often one is asked for *chits*. The driver of a carriage plying for hire in a large station once asked the writer for a *chit* to say that his harness had broken down. A most extraordinary story in this connection was told by a lady in a mission hospital, who had looked after an Indian patient, admitted, let us say, on the 10th of the month, and discharged cured on the 25th. On departure he asked the lady for a *chit*. This was no unusual request, and the lady gave him one. After examining it, he asked her to alter the date of admission to the 5th. The lady naturally refused, whereupon the man went off to the doctor, to whom he offered a rupee for an amended date. Needless to say, the doctor refused, whereupon the man returned to the lady with two rupees. He spent a considerable time going from one to the other, offering higher and higher amounts until he reached Rs. 100. This was apparently his limit, for he went off in disgust and they saw him no more. The lady could only surmise that he wished to be able to prove an *alibi* in some criminal case.

The Indian peasant is immensely pleased if, when out in the country, one does a little amateur doctoring. He has a touching faith in a little white medicine, a faith which, no doubt, often brings about its own cure. But it was very amusing on one occasion to see a peasant first pass his hand before his sick child's face, to avert the evil eye, and then bring it forward for medical treatment!

An officer, halting for the night at a village in Kashmir, was asked to cure a cow, which had just been bitten by a snake. He effected an operation in the method laid down in the *F.S.P.B.*, viz., by making a cruciform incision, and putting permanganate of potash crystals in the wound. He returned to the village some weeks later, and as soon as his arrival became known, a large crowd gathered, most of them leading cows. He asked the reason, and was told, "*Sahib*, you remember the cow you cured of snake-bite? Well, she began to give milk from that very day, which she had never done before, and these men want you to do the same to their cows."

FIELD ENGINEERING APPRECIATIONS.

By MAJOR J. H. DYER, M.C., A.M.I.MECH.E., R.E., *p.s.c.*

I. INTRODUCTION.

"The value of method is very apparent in war, where there are so many disturbing influences and where rapidity is often of the utmost importance."—(*Training and Manœuvre Regulations*, 1923, para. 25 (3).)

There is no mystery about an appreciation; it is merely a methodical way of coming to a decision and forming a plan. The process tends to develop the qualities of foresight and constructive imagination, which are as necessary in field engineering as in tactics or strategy.

II. TYPICAL FIELD ENGINEERING PROJECTS.

1. Bridge construction, or reconstruction.
2. Landing piers, floating or fixed.
3. Arrangements for entraining or detraining troops.
4. Demolitions.
5. Water supply for a mixed force.
6. Fieldworks for the attack or defence of a position.
7. Road construction or repair.

III. TABLE SHOWING FACTORS WHICH MAY BE APPLICABLE TO THE ABOVE-MENTIONED PROJECTS.

(*Note:* Reference Nos. refer to those in paragraph II above.)

Factor.	*Type of Project to which applicable.*
Tactical considerations	All.
Time	All.
Distance	All.
Labour	All.
Stores	All.
Tools	All.
Plant...	All.
Transport	All.
Approaches	1, 2, 3 and 5.
Possibilities of a diversion...	1, 4 and 7.
Area in which workshops can be sited ...	All.
Nature of traffic	1, 2, 3 and 7.
Tide, weather, floods	1, 2 and 7.
No. and length of trains	3.
Watering facilities for locomotives ...	3.
Earthwork involved	3, 5, 6 and 7.
General slope of area	3 and 5.
Nature of subsoil	6 and 7.

The above is merely intended as a guide. Only those factors should be considered from which a deduction is made influencing the choice of plan. Thus many of the above factors may be omitted from this portion of the appreciation, though subsequently dealt with in List of Requirements, etc.

IV. Specimen Notes on the Items dealt with in an Appreciation.

1. *Object.*—This will be obtained from the orders or instructions received. It should be as precisely defined as possible, *e.g.*, rather than stating the object as "to prepare bridge for demolition by hasty method," it is preferable to state "to prepare bridge for hasty demolition by 1500 hrs. to-day, and thereafter prepare for deliberate demolition as time permits."

2. *Considerations which affect the Attainment of this Object.*—(a) *Tactical Considerations:* Necessity for concealment of reconnaissance from the enemy; *e.g.*, prior to a river crossing, reconnaissance may only be advisable at night. Somewhat obvious reconnaissance may be fairly safe for the officer carrying it out, but it is unpopular with the troops who have to make the assault in that sector after the enemy has been thoroughly warned of impending events!

In construction of field defences, where concealment from the air of actual machine-gun posts is essential, their construction might not be started until camouflage material is available on the site. In addition, where ample time is available (such as the construction of a "Hindenburg Line"), the enemy may be deceived by so multiplying the defences that he is in ignorance as to which are the important centres of resistance.

(b) *Time*: Always an essential consideration in field engineering, generally taking precedence over economy in material and labour. In this connection, time for obtaining approval of design is often not available on active service. "Junior officers must be prepared to take much greater responsibility in the settlement of the design and engineering details of a scheme than is entrusted to them in peace." (*Engineering Training*, Vol. II, Sec. 54 (3).)

The time factor affects the necessity for night work; arrangements for lighting, if required, must be made in good time.

(c) *Distance:* From camp to site of work. Consider if it would pay to bivouac on the site.

(d) *Labour:* The full strength of a unit is seldom available under active service conditions. Thus, with Home War Establishments, it would be unsafe to reckon on more than 140 actual workers from a Field Company, or 40 from a Section. Incidentally, in working out projects in peace, some officers suggest breaking up sections: this was never done in the writer's war experience with a Field Company.

The demand for Sapper labour for relatively skilled work is always likely to exceed the supply. It is, therefore, most undesirable to use Sappers for such tasks as digging or wiring where working parties from other arms, or civil labour, can be made available.

(e) *Material (stores, tools and plant) :* Much delay is likely to be involved if demands exceed the allotment for the division in area R.E. Parks or dumps. Permissible substitutes must be considered, as these may be in stock, in the event of a shortage of original requirements.

(f) *Transport :* The fullest possible utilization of carrying capacity should be made, but it must be remembered that on bad roads, or owing to the bulky nature of the stores being carried, a vehicle cannot always be loaded to full rated capacity. Stock steel spans require particular consideration ; on account of their length, special lorries may be required for them.

(g) *Approaches :* The work involved may often be a determining factor in the choice of a bridge site.

(h) *Possibilities of a diversion :* In bridge construction, a temporary crossing is generally essential, clear of the line of the permanent structure.

In demolitions, it is essential that there should be no easy diversion. Thus road cratering is usually only worth while attempting in marshy or soft ground, cuttings, embankments or woods. Incidentally, road craters near buildings are usually fairly easily repaired by shovelling the brickwork into them : this was very noticeable during the German withdrawal to the Hindenburg Line in 1917.

(i) *Nature of traffic :* In a road-repair project, in a case where traffic will be intermittent, it may be the best policy to confine the work done to improvements to drainage and temporary repairs to the worst sections of the road. If intensive repairs to a road are attempted in a short time, the damage done in distributing road metal by heavy lorries (and in India still more by bullock carts) may more than outweigh the value obtained from the material delivered. The possibilities of wire-netting and of " mix-in-place " methods should always be considered. Heavy repairs can only be carried out if traffic is taken off the road.

(j) *Weather and floods :* In a road project, it must be remembered that an unmetalled cart track may stand up to M.T. traffic for some time in dry weather, but would not take it at all in wet weather, especially in low-lying country.

(k) *Nature of subsoil :* In a field defences project, this greatly affects the output in digging, also the amount of revetment required in breastworks, trenches or dugouts.

3. *Courses.* This item may often be omitted. Only consider likely courses, do not mention courses for the sake of dismissing them as impracticable. As an example of reasonable alternatives,

in the case of a bridge demolition, consider attacking haunches, crown, piers and abutments and work out approximate time for preparing and laying charges for each.

4. *Plan.* (a) *Priority of work* (if more than one project involved).

(b) *Order of starting work* (if only one project involved). Work which will take the longest should generally be started first, *e.g.*, the pile driving and approaches in a bridging project.

(c) *Allotment of work to units, or sub-units:* Task work is most desirable, particularly for infantry working parties.

(d) *Material:* List of requirements and order in which required. It is nearly always worth while to send an officer to supervise drawing of material, or at any rate a most reliable and energetic N.C.O. should be sent. He should know what are permissible substitutes, in case the original requirements are not forthcoming: the personnel at the store dump cannot be expected to help in this respect, as they probably know no details of the work in hand.

(e) *Allotment of additional labour and transport:* To units or sub-units.

(f) *Arrangements for night work:* Lighting, guides, etc.

(g) *Provision for rapid off-loading of transport:* *e.g.*, in a bridging project, only such number of lorries as can be dealt with simultaneously should be allowed on the site at any one time, otherwise congestion and difficulty in turn-round will be liable to occur.

(h) *Engineer reserve:* Not usually necessary when faced with a definite project or projects. But where engineer liabilities are uncertain, say at the start of an attack, an engineer reserve is essential to meet unforeseen demands.

(i) *Technical details:* *e.g.*, placing of charges for a bridge demolition, should be largely given in dimensioned sketches.

(j) *Accommodation and rations:* Trouble taken in arranging to make the men as comfortable as possible and providing them with hot meals is well repaid in output of work.

V. Conclusion.

It is not contemplated that an officer should sit down and make an elaborate written appreciation each time he is faced with a field engineering problem. On the other hand "the habit of making appreciations teaches an officer to arrange his facts methodically and trains him to arrive rapidly at a logical and sound conclusion." (*Training and Manœuvre Regulations*, 1923, para. 25 (3).)

Finally, the writer wishes to stress that this article is in no way intended to be exhaustive, but merely to call attention to the value of methodical consideration of the factors involved in a field engineering appreciation.

PROFESSIONAL NOTE.

VERTICAL SHAFT SINKING BY THE FREEZING METHOD.

By LIEUTENANT L. O. W. WOOLDRIDGE, R.E.

(*See also R.E. Journal, September*, 1923).

THIS process is not new ; it was first exploited by a German engineer named Poetsch in 1890. The basic principle of the process is to improve the condition of the ground to be sunk through, both from the point of view of its water content and of its stability.

As with cementation, the freezing method is applicable to measures which are both water-bearing and unstable in character, and also particularly in solidifying running sands, which do not lend themselves readily to cementation.

This solidification by freezing, while only temporary, is complete, and the frozen wall formed might be regarded as a concrete one, using ice as the medium instead of cement.

The application of the process is as follows : On a circle round the shaft to be sunk and of nearly double its finished diameter, boreholes are put down, at uniform intervals, 3 to 4 ft. apart, to such a depth as to pass through all the dangerous ground and to continue a certain distance into the solid ground below. Each of these boreholes is equipped with a freezing circuit, consisting of an outer steel tube, about 6 in. diameter, closed at the bottom and containing inside it a central pipe about 1½ in. diameter open at the lower end. Freezing brine is pumped down the central inner pipe and returns up through the annular space between it and the outer pipe. All these are connected together by two ring mains, one the flow and the other the return circuit.

The refrigerating plant consists of a normal cold-producing ammonia circuit, the refrigerating coils of which are placed in a brine tank, which brine is circulated by a pump, through the ring mains and the borehole freezing pipes. Thus the low-temperature brine which is continually fed to the boreholes absorbs heat from the ground, thereby freezing the water contained therein.

After a period, which may vary from two to five months according to the relative size of the shaft and of the refrigerating plant, and

various other circumstances, the frozen cores created round each borehole increase in diameter, connect together and form a water-tight wall round the shaft. Sinking can then be proceeded with in safety as by ordinary methods.

In the early days of the process, the failures were due to two principal causes. Firstly, the borehole pipes themselves were used for the freezing circuit, and secondly, due to the inability to survey the boreholes accurately. The first of these causes of failure was the result of the brine leaking from the joints of the pipe and dissolving the ice wall. The present practice is to place the freezing pipes in position inside the borehole pipes, and then to withdraw the latter, unless this is impossible and they have to be left in the ground.

The accurate survey of boreholes is a study in itself, for except for very shallow ones, it is said that the borehole which did not deviate from the vertical has yet to be put down. It is obvious that if the annular wall of frozen earth is to be solid, the boreholes must not deviate much from each other, as, either the frozen cores round the boreholes may never join, or the time taken to close the wall will be very prolonged. It is thus essential that the boreholes should be accurately surveyed and plotted so that it is then possible to decide as to the advisability of putting down an extra borehole between two erring ones. For shallow boreholes of from 200 to 300 ft. deep, it is possible that ordinary simple methods may be sufficiently accurate, but beyond that depth it is essential that some instrument such as the Denis-Foraky Teleclinograph be used, for it is really upon the accuracy of the boreholes that the success of the freezing method nowadays depends.

In the centre of the site where the shaft is to be sunk, a pilot borehole is first put down to the full depth that the shaft will be sunk. This will, of course, firstly give geological section of the ground to be sunk through and will afterwards give an indication as to when the ice wall has closed. When the freezing has commenced, the level of the water in the pilot borehole is plotted against the level of the water outside the ring of freezing tubes. This may be a tidal reading or obtained from another test boring according to circumstances. When the level of the water in the pilot hole starts varying independent of the level outside, it is an indication that the ice wall has closed. Further indications are taken from the temperature of the flow and return of the brine and thus an expert can decide when it is safe to start sinking.

Once sinking has begun, only about a quarter the available refrigerating plant is kept running to maintain the frozen wall. If there is an adjacent shaft to be sunk, the remainder may be turned on to freezing it. Even with this maintenance the wall gets thicker and about a month after sinking has begun it will probably be found that the shaft is frozen solid to the centre.

An ordinary air pick (concrete breaker) is used for excavation, the material being hand-shovelled into the hoist bucket. For frozen clay, an air shovel may be used for excavating if free from pebbles, but if large pebbles are met with progress becomes slow, and blasting may have to be resorted to. This has to be carried out skilfully so as not to damage the frozen wall proper or the freezing tubes. A circle of charges is placed in holes made with a rock drill, on a diameter about one-third that of the shaft. After these are fired, further "easing" charges are placed halfway between the resulting crater and the wall of the shaft. Finally, after these are fired, small "trimming" charges are placed round the diameter of the shaft. It will be seen that the procedure is much the same as with tunnelling, with the important exception that the charges are never all placed at once and fired in succession by means of delays, as the risk of damage would be too great.

Generally speaking, by the freezing method, it is quite safe to work down to a depth of about 150 ft. without placing any lining at all. It is then usual to place a crib and build up to the top of the shaft with the permanent cast-iron lining segments. If possible, the crib is placed in an impermeable stratum, so as to seal off that part of the shaft. Sinking is then continued, in depths of about 150 ft. as before, if required, until the necessary overlap, into the good measures below the water-bearing strata, is obtained, so as to form a good seal. Here the cast-iron lining is terminated and after the shaft has been thawed, usually by circulating warm brine instead of cold, the leaks are located and caulked where necessary and/or grout is injected under pressure through the tapped and plugged holes in the cast-iron lining. After that, if further depth is required, sinking is carried on through the good measures in the ordinary way.

In hot climates the first few feet may contain little or no moisture, so as to be impossible to freeze it. In that case, when the frozen wall is completed below, and sinking is commenced, a temporary lining has to be placed, to retain the unfrozen ground.

Certain types of clay will retain their plasticity even when frozen, and in this case they will bulge out under the pressure. In these circumstances the permanent lining will have to be placed at once before further sinking can proceed.

It is interesting to note that the greatest depth yet carried out by the freezing process is a shaft at Houthalen, in Belgium, by the Foraky Company of Brussels. This shaft is 2,060 ft. deep and 18 ft. diameter. A similar shaft adjacent to the first is nearing completion. The greatest diameter of a shaft, also by the same firm, is 75 ft., the depth being 90 ft. In this case 116 boreholes in a double ring were used and the frozen wall was estimated to be 20 ft. thick.

All Reviews of Books on military subjects are included in the provisions of K.R. 522c.

BOOKS.

(Most of the books reviewed may be seen in the R.E. Corps Library, Horse Guards, Whitehall, S.W.1.)

MARLBOROUGH: HIS LIFE AND TIMES.

By WINSTON S. CHURCHILL.

VOL I.

(Harrap. Price, 25s.)

THIS first volume of the eagerly-awaited life of Marlborough takes the story up to the formation of the Grand Alliance and the death of William III. It is the story of the Court and of political and domestic influences rather than of military affairs, so far as Marlborough is concerned, and at last we have an account freed from the venom of Macaulay's pen, dipped in the ink of scurrilous pamphleteers such as Mrs. Manley, authoress of the scandalous and obscene *The New Atlantis*, source of so much of Macaulay's slanders. The present author does not attempt to hide Churchill's gains from his sister's liaison with the Duke of York, nor his relations with the Duchess of Cleveland, nor that he received considerable sums from the latter when she had become his mistress: but that was an accepted state of affairs of the times and particularly of the Restoration Court. In a period of considerable debauchery, Churchill was really singularly temperate: he refused to make a *mariage de convenance* with a wealthy heiress, who incidentally later became another of the royal mistresses, but faced real poverty to marry the remarkable Sarah Jennings, to whom he showed an almost pathetic lifetime devotion. Mr. Winston Churchill has for ever destroyed the fantastic picture which Macaulay in particular, and others following his example, have painted of Marlborough as a monster of depravity and avarice.

From the military point of view, one can really see little in this period which would give indications of Marlborough's later complete supremacy. The author gives a graphic description of the young and courageous soldier of Maastricht and Enzheim —" my handsome young Englishman "—of the decisive leader of Sedgemoor, and of the Irish strategist: but for the greater part of the Continental wars of William's reign, Marlborough, thanks to the belief of the King that no Englishman knew anything of the art of war, had to remain an indignant and almost despairing spectator. The really important aspect of this volume is that of the political arena. The author explains very clearly the situation, which appears almost fantastic at times—Whigs plotting against Tories, Roman Catholics against Protestants, one part of the Royal Family against another, and finally, the King of England being heavily subsidized by Louis XIV to enable him to govern in his own way without summoning Parliament to vote him funds and at the same time to restrict his powers. Incidentally, he produces a somewhat unexpected picture of Charles in his later period as a consummately clever but constitutional monarch. Marlborough, by his position in the household of the Duke of York, was in the midst of all these troubles in the Stuart period, while his devotion to Princess Anne involved him in all the dynastic family

quarrels again after the Revolution. But here again the author, by detailed analysis of the records, completely refutes the slanders of Macaulay. It is true that Marlborough opened up correspondence with William and finally abandoned James, but this was not the mean desertion that it usually has been depicted. Marlborough himself, for many years at any rate, obtained no advantage from his actions: but he saw disaster to the country and to the Protestant religion, his sincerity for which even Macaulay does not doubt, in a continuance of James' reign, and he faced the consequences. It is clear now, too, that when he transferred his allegiance to William, the success of the latter appeared very doubtful: he risked everything, but not purely for personal gain.

The author then scrutinizes most carefully the records of Marlborough's next reputed intrigues, against William, with James in exile. Analysis of the documents, he shows, gives definite indications that few of the Jacobite records can be trusted: many were unquestionably written from memory and specially to incriminate individuals. This is clear from the Nairne papers. There is probably little doubt that Marlborough did correspond with James: most prominent men of the day did so: but this was only to keep "one foot in the other camp." William knew about it and probably made use of it. The procedure was little more than the courtesies in vogue between opposing commanders in the field. The story of the Camaret Bay letter, however, that letter which Marlborough is supposed to have sent to the Court of St. Germains, warning them of the proposed descent on Brest, is more strongly supported by evidence. Mr. Churchill devotes a whole chapter to this incident, and, as a result, one must be convinced of, at any rate, the extreme improbability of his complicity. Unfortunately for him, being much in the limelight, Marlborough was a constant target for forgers and for false accusers.

His fortunes under William, before Mary's death, seemed at the lowest ebb. He had admittedly been one of the leaders against the King's policy of employing only foreigners in the high places, while the Queen hated him for his championship of Princess Anne, for whose immediate claim to the throne he was at one time suspected of plotting. The King and Queen tried to strike at him through Anne, who was ordered to get rid of her beloved "Mrs. Freeman," and at the same time Marlborough was relieved of all his offices. The Young forgeries followed. His complete association in the Jacobite plot was believed, and he was flung into the Tower. The sudden detection of the forgeries and the consequent collapse of the case alone probably saved him from the scaffold. Yet once again he had to face disaster in the accusations levelled against him in the Fenwick trial: this time he took the counter-offensive and saw Fenwick beheaded in 1697.

At last we see peace and reconciliation between the two men essential to the welfare of Europe and the breaking of the French power. William turns to the future dominating personality and we have Marlborough, after William's death, the close friend of the Queen, at the head of the Grand Alliance, which he had himself organized, ready to start, at a relatively late age, that amazing military career which must mark him as the equal of any commander in history.

This volume gives a remarkable picture of the man and his personality. In politics, he was really a non-party man: he looked to individuals and particular causes rather than to party ties; and he laid that foundation of handling kings, politicians, and ambassadors, which enabled him later to hold Europe together. He was avaricious undoubtedly, but it was an avariciousness born of poverty, and he could spend regally when he thought it wise. He was the almost classic example of a supremely devoted husband.

Mr. Churchill has at last given us a rational analysis of the man, written in that crisp, live prose which makes him one of the greatest living masters of English. Having read this book, one now still more eagerly awaits his account of Marlborough, the European General.

H.G.E.

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

VOL. IV. THE A.I.F. IN FRANCE.

By C. E. W. BEAN.

(Angus & Robertson, Sydney. Price, 21s.)

To those who have not studied other volumes of the Australian Official History of the War, a first introduction to the series causes one some little surprise. One has read our own Official History where the big picture looms supreme, and only occasionally does one descend even to the level of the battalion. Or one may have perused histories of regiments or divisions, where the particular unit or formation fills almost the whole canvas, and details of actions of quite small units are included. In the Australian history, however, the compiler tries to draw for his readers both the general outline of the strategy of the war as a whole, and also the doings of Australians and the Australian Corps in particular in the minutest detail. The actions of platoons, sections and individuals are not adjudged too insignificant to be recorded, and not only the names of individuals who distinguished themselves or who commanded units are given, but in footnotes potted histories of these men are added. These notes include ultimate rank, date and place of birth, occupation, etc. and render the book a very human document to the interested reader, and a sacred record to those to whom the individuals are related or with whom they served.

The details of the actions recorded are culled from official documents, private letters and diaries, or personal reminiscences of the actors. The collection of this mass of detail bears eloquent tribute to the industry of the author who, as official war correspondent to the A.I.F. throughout the war, was well placed to have collected much of the information on the spot.

The period covered by this volume is the year 1917, and embraces particularly the German withdrawal in the Somme area, the Arras offensive more especially as regards its repercussions at Bullecourt, the battle of Messines, and the third battle of Ypres. Of these the actions at Bullecourt and the approach to Passchendaele, are particularly connected in one's memory with the Australian Corps.

Unfortunately our own Official History has not yet covered this period, and in default of any other authoritative work, it is difficult to check the judgments of the author on the operations involved.

The author's judgments of individuals and actions are outspoken to a degree, and confident, as becomes one of his race, for Australians are never prone to suffer fools gladly or to hide their views. Such frank criticism is refreshing, and even if further investigation tended to put a different complexion on the evidence, it is fair " barracking," and is applied even more freely to Australian officers than to those of other nations. The criticism, however frank, is never bitter, even in the telling of the action of Bullecourt, of which few Australians at the time could be heard to speak with moderation.

With regard to the battle of Messines, the author claims to show for the first time that the 13th Australian Infantry Brigade, by widely extending to its left, filled a vital gap at a critical moment when certain other troops failed to arrive. He says that the " Commander of one of the Brigades concerned expressed himself as simply " astounded when the present narrative was submitted to him." We shall look forward with interest to see what account our own Official History will give of the incident, more especially as the reviewer, who was serving with a division still farther to the left, remembers the surprise which the presence of Australians close to the divisional area caused.

From the Sapper point of view, the most interesting part is the three appendixes dealing with the mining operations at Hill 60, Nieuport, and Hill 70. The technical details add little to our own records of mining in the Great War, but again the human element makes the accounts very readable.

In the general narrative there are some surprising statements with regard to

engineers. For example, we read of "The Chief Engineer (*sic*) of the division, "Lieut.-Colonel H. O. Clogstoun (of Anzac fame)." And surely as late as 1917, even with the Australians, the failure to wire front-line posts should be put down to the fact that "this was a precaution unpopular, apparently, with most British "troops, and certainly so with the Australians" (page 109), rather than that "the "field companies and pioneers, which would ordinarily have been sent to supervise "the work, were engaged in making roads" (page 358). The normal employment of engineers on wiring front-line posts had died in France long before Bullecourt, but perhaps in this, as in many other respects, the Australians were a law unto themselves.

Such a detailed account of operations brings out many points both in major and minor tactics. The author shows the reactions both on operations and on morale, as far as Australians were concerned, of the various methods of advance by very limited objectives tried at Messines and in the third battle of Ypres.

His account of Bullecourt shows very clearly the difficulty of a commander getting accurate information of the progress of his troops—a problem that exercises our minds in post-war training. The difficulty of getting reports back from the leading infantry, the use and dangers of information from artillery forward observing officers and aircraft, the importance of Brigade and Battalion Commanders being well forward, the value and disadvantages of liaison officers, are all well illustrated, and provide much food for thought.

When I picked up the book, with its 967 pages, full of detail, I intended to skip pretty freely, but I confess that the human interest of the book, coupled, perhaps, with happy recollections of Australia and the Australians, gripped me and I read every word. Even those who do not feel disposed to tackle so large a volume, would be well repaid by a study of a few of the principal actions. I would specially recommend such action to young officers and N.C.O's. The story brings out in a remarkable way, the enormous responsibility of leaders of the most junior rank in the war. Again and again we read of attacks reorganized, consolidation effected, and mistakes corrected by subalterns, N.C.O's and privates, men who a year or two before were, as shown in the footnotes, solicitors, farmers, bank clerks, plumbers, dock labourers.

Excellent little inset map-diagrams add greatly to the value of the record.

Finally, one cannot close a review of the volume without a tribute to the magnificent troops whose story is here told. The author, even though critical at times, is generous in his tributes to the troops of the rest of the Empire, especially the New Zealanders, the original "diggers," and, if he may seem to stress the glory of the Australians, we must remember it is written for Australians, and that the Australian Imperial Force "deserved well of their country."

R.P.P-W.

WAR MEMOIRS OF DAVID LLOYD GEORGE.

VOL. I.

(Ivor Nicholson & Watson. Price, 21s.)

Mr. Lloyd George's book was expected to be sharp, outspoken and unsparing in criticism; and it is. The criticisms on other leaders, now dead, are too sweeping and scathing to be accepted as fair. No one will deny Mr. Lloyd George's title to the nation's gratitude for his vigorous leadership and his handling of the munitions problem. He liberally claims this title; and his book shows good reason for it. But he would have been an even greater man if he had been more magnanimous; there were others who also devoted all their powers to their country's service.

In his chapters on munitions, Mr. Lloyd George writes his best. There is no question here of his magnificent work for the country; and for these chapters alone the book is worth re-reading. If no other man but Lord Kitchener could have raised the new armies, no other man but Mr. Lloyd George could have handled the munitions problem so thoroughly. He transformed the country. It was a hard thing for him,

as he himself says—imbued as he was with ideals of peace and social reform—to have to devote four and half years to the strenuous production of engines of war and destruction. The more credit to him. His vigorous policy, his selection of the right men, his methods of short-circuiting laborious red-tape were all vital to success; and many of the features of welfare in industry at the present time were introduced under his control during the war.

No one can read the book without feeling that most of the author's criticisms of the obstruction and ineffectiveness which he met with are justified. But he is not always fair in allocating the responsibility. He fastens on Lord Kitchener all the War Office mistakes; and the mistakes were not all those of the War Office. Lord Kitchener took over the War Office only on the outbreak of war; he could not be acquainted with all the plans prepared by the General Staff, and most of that Staff had been taken away bodily in the Expeditionary Force. The colossal task was beyond even his abnormal powers of organization. He centralized everything in himself, while Mr. Lloyd George began his task by the widest decentralization.

Mr. Lloyd George, however, seems to forget that the pre-war warnings by the soldiers fell on deaf ears in the Cabinet. He was a prominent member of the Cabinet which would not listen to Lord Roberts, and which incurred the danger of civil war over Ulster right up to the eve of the Great War; he himself had uttered the warning to Germany in his famous speech at the Guildhall, on 21st July, 1911. He attended the meetings of the Committee of Imperial Defence of which he was a member. He knew the imminent danger of a Continental war. But he also knew, as Chancellor of the Exchequer, how cramped and confined the military authorities always were; that it was hard enough to secure money to maintain the small existing forces, and quite impossible to obtain funds for establishing even a skeleton scheme for wider expansion. He need not, therefore, have been so astounded at our unpreparedness.

Nor is the whole of the credit for organization of the munition supply due to Mr. Lloyd George. The foundations laid by Lord Kitchener are either hidden or ignored; yet the gradual improvement in supply in 1915 came from arrangements made by Lord Kitchener in 1914; it was well into 1916 before the harvest from the Ministry of Munitions began to flow in. Lord Kitchener built on next to nothing; Mr. Lloyd George came in with the first storey begun.

Mr. Lloyd George, once awakened to the danger of the situation, did not stint his whole-hearted assistance. If, as pre-war Chancellor of the Exchequer, he had had to starve the Services in favour of social reforms, he made no such difficulties in time of war, and at once placed ample funds at the disposal of the War Office.

He says that, before the war, he was in favour of national service, and describes how he tried to obtain a party truce to close the ranks in face of the great danger which he knew to be impending. If his scheme for training on the Swiss Militia system had been adopted, if England had had a million and a half militia-trained men with arms ready—and had shown her determination to use them if need be—it is indeed probable that there would have been no war. But was there anything in Mr. Lloyd George's actions and speeches at that time to show that he would back the expense? Did he influence the Cabinet in any way towards supporting Lord Roberts, who was touring the country, urging much the same thing?

Mr. Lloyd George tells us that his plans were rejected owing to the antagonism he had aroused with his scathing attacks in his speeches and his extremely radical proposals. His political opponents at the time could not forgive the taunts at Limehouse. Thus did political strife prevent the creation of what might have saved England, Europe and the world from the awful catastrophe which fell upon them.

In his chapter on the strategy of the war, Mr. Lloyd George boldly enters a field where one might expect the political amateur to be caught up in the toils of conjecture. But apart from one or two overdrawn statements, this chapter is as well worth study as are the others. He quickly grasped the essentials of the strategical

situation, and his memorandum of 1st January, 1915—which curiously coincided with almost similar but independent proposals from Lord Kitchener and General Gallieni—shows a remarkably clear view of the problems which confronted the Allies after the campaign of 1914.

In his eagerness to condemn nearly all British Generals, however, he does not allow for the fact that it was impossible to sit down on the Western Front and leave all initiative to the Germans. The latter would have transferred large forces to the Eastern Front much quicker than the Allies could have sent troops to the Balkans, and it is more than probable that the Germans would have put Russia out of the war before the Allied attack in the East could have affected the situation. The French, throughout 1915, were always pressing for stronger British participation on the Western Front, and more than once hinted that we were not pulling our weight there.

But without weakening our Western Front more than it was, the forces absorbed in the Gallipoli venture could have been more profitably sent to Salonika instead. Had all those Gallipoli divisions been employed in an Allied expedition based on Salonika, the Balkan scheme would have had every chance of success, and success in the Balkans would have brought about the isolation of Turkey and her rapid capitulation; to say nothing of all the other strategical benefits. England had neither the men, the guns, nor the shipping to support both Salonika and Gallipoli at the same time; Lord Kitchener was persuaded by Mr. Churchill to back the Gallipoli venture. It is a common failing of political strategists that they ignore the "A" and "Q" side of war.

Mr. Lloyd George, moreover, writes in favour of a proposal which he says was made by Sir John French for the initial landing of the whole B.E.F. at Antwerp in August, 1914, to co-operate with the Belgians and attack the German flank. There is no mention of this in Sir John French's book, "1914," although he was Chief of the General Staff for some years prior to the war, when the French and British Staffs had been in close consultation on the question of the British concentration. Mr. Lloyd George forgets how exposed to submarine attack our communications across the North Sea would have been. A glance at the situation of Antwerp will show how precarious our position would have been, with the Dutch in command of both sides of the Scheldt estuary. The only chance of success required the complete co-operation of the Dutch, and the attitude of Holland did not favour any such hope.

Mr. Lloyd George describes the French Government as having fled to Bordeaux during the "panic of August." Does he not remember the predicament in which France found herself in 1870, when the shutting-up of the Government in Paris prevented the organization of the national defence outside? The move to Bordeaux in August, 1914, was a wise and necessary step. It was, of course, a hurried move, but it is unfair to our Allies to describe it as a panic flight.

There is a good deal of repetition in the book, especially in the last eight chapters. But these *Memoirs* ought to be read and re-read, and their lessons deeply impressed on all who may in the future have to direct the nation in time of danger.

W.H.K.

THE STAFF COLLEGE EXAMINATION LECTURE SERIES.

By Brevet Lieut.-Colonel B. C. DENING, M.C., R.E., *p.s.c.*

(The Civil and Military Press, Lahore. Price, 8s. 6d., from the author, Staff College, Quetta, or at "Four Acres," Velmead Road, Fleet, Hants.)

It is a matter for satisfaction that a high proportion of officers nowadays recognize the value and importance of the Staff College course as an essential element in the equipment of those who aspire to high command. The value to the Army as a whole of the intensive study of the art of war by so many officers is fully recognized

by Army Headquarters, and much trouble is taken in all important military centres to assist officers in their preparation for the examination. There are unfortunately many small stations in which these facilities are not so easily afforded, and it is for the officers in these stations in particular that Lieut.-Colonel Dening's Lecture Series has been written.

This little book of 95 pages consists of a number of lectures or notes on the subject matter of each of the seven obligatory papers. The author's intention is to stimulate thought and to direct research on up-to-date lines. In his introduction he specifically rejects any claim to providing the complete answer, even if it were possible to do so. Although much familiar ground is covered it may be said at once that these thirty-seven lectures are compact with ideas and information and will be found of real value to the thoughtful and constructively minded student. It is the more to be regretted that the work is to some extent marred by a slovenly style and a number of ungrammatical passages out of keeping with the author's literary experience. The reader is given the impression that a mass of memoranda has been " thrown off " at high speed and despatched to the printer without more ado.

There is so much information and discussion in these lectures that detailed examination of the author's ideas and conclusions would be too lengthy for a review of this nature. The outstanding feature of the series is the prominence given to the profound effect on every aspect of military strategy, tactics, administration, organization, and of Imperial Defence, of the internal combustion engine, whether installed in an A.F.V., transport vehicle, aeroplane or ship.

In lectures III and IV, Lieut.-Colonel Dening brings out clearly two important points; firstly, that the fighting strength of a nation now depends in very large measure on its industrial capacity rather than on the size of its population, one of the most difficult factors to assess in any discussion on equality of armaments and a prime cause of the modern tendency towards nationalistic self-sufficiency in the economic sphere; secondly, that although the petrol engine has increased the speed and mobility of individual fighting units, nevertheless, the problem of bases, ever the limiting factor in the mobility of naval forces, is now presenting itself in a more acute form to the other services. In the paragraph on naval bases it might have been pointed out that fuel consumption is a vital element of naval strategy. Naval actions are fought at high speed with a very high rate of fuel consumption. A fleet cannot, therefore, afford to fight after a prolonged voyage until it has refuelled; destroyers in particular are handicapped in this respect. With the bases of the combatants perhaps 1,000 miles apart, the fleet that fights near its own base has an overwhelming advantage.

In lecture V the author discusses the question of the influence of seapower on strategy under modern conditions. Great Britain has, in the past, always depended on her seapower to enable her to select her point of attack against a continental opponent. Lieut.-Colonel Dening assumes that this will continue to be so in the future. It is, however, worth while considering how far air forces will in future restrict the power of a maritime nation to select its point of attack at will. Against an opponent well equipped with aircraft, to effect a landing on the hostile shore within reasonable distance of a vital objective will be a most hazardous operation. The base facilities during the critical first stage will be as concentrated and vulnerable a target as aircraft can desire. Seapower will still enable landings to be made at any point on friendly territory as in the Great War, and will in favourable circumstances enable seaborne aircraft to attack land objectives.

Lecture VI on the influence of economics upon world strategy is valuable. No strategical study is complete, can indeed be usefully undertaken at all, without profound consideration of the economic factor, for with nations in arms economic objectives become of vital importance and to attack them may well prove the best way to obtain a decision against the hostile armed forces and of bringing these forces to battle.

Lectures IX and X deal with the influence of A.F.V's and M.T. upon attack and defence. Here Lieut.-Colonel Dening stresses the fact that country will tend to become divided into tank country, infantry country and country suitable for the co-operation of all arms. Undoubtedly strategical study of a plan of campaign will in future take into account the areas or avenues suitable to the movement of tracked vehicles, and combatants strong in A.F.V's and cross-country transport will seek to obtain a decision in these areas. At the same time experience has shown that the use of large masses of M.T. is apt to defeat its own object by causing serious traffic difficulties, whilst congested roads and concentrations of A.F.V's form ideal targets for aircraft attack. The author envisages the use of armoured and mechanized formations from well-defended bases pushed forward in rear of the mobile forces. The defence of such bases against attack by hostile mobile forces and aircraft will be a problem requiring the closest study.

Lectures XIV (Defence of Ports), XVI (Security of L.-of-C. under modern conditions), XX (Co-operation with the R.A.F.), are all interesting though frequently controversial. Lectures XXIV and XXV on the maintenance of mechanized forces again touch on a number of important problems. If the attributes of the A.F.V. are to be utilized to the full, supply must be flexible, rapid and secure. The maintenance of mobile forces at great distances in front of railhead is a peculiarly difficult problem, but if mobile forces are to attain their fullest effect it must be mastered. The essence of the problem of the use of mobile forces is that the objective must be selected with the greatest care. The number of A.F.V's available in the early stages of a campaign will be limited, as no country can afford to maintain large armoured forces in peace. The difficulty of rapid replacement of casualties will be such that a commander will hesitate to employ his limited resources except against an objective, which, from its vital strategical importance, will justify the use of so powerful a weapon, the expenditure of irreplaceable and costly material, and the maintenance of long and vulnerable lines of communication.

It is important to remember that the open rolling or desert type of country referred to by the author as tank country may also be classed as aircraft country. Movement is visible from the air over great distances, tracks across country are conspicuous, landing-grounds are frequent and concentrations or columns of A.F.V's may be unable to operate freely unless protected by a high degree of air superiority.

Lectures XXVI to XXVIII deal, ostensibly, with Organization, Administration and Transportation (Peace); No. XXVII, however, on the effect of the Indian Constitutional reforms on Imperial Defence, seems to be out of place in this section.

The Cardwell system is, of course, the main stumbling-block in the way of an expansion of our armoured and mechanized forces, and Lieut.-Colonel Dening outlines admirably the difficulties that face the responsible authorities in this respect. If, in a later edition of this book, the author would include a few extracts from the table of comparative costs of representative units as published in the *Army Estimates*, students would be assisted in arriving at practical conclusions on the financial effect of any schemes that may present themselves as possible solutions to this problem. In this connection, all candidates for the Staff College are recommended to read the series of three articles on this subject that appeared in *The Times* this summer: obviously the work of a peculiarly well-informed authority, a master of his subject, though even in these articles financial difficulties are not given quite their full weight.

In Lecture XXIX, History and Organization of the Empire, we must once again note the stress rightly laid on economic factors. No mention is made in these lectures of the over-riding problem of the co-ordination of Imperial Defence between the various States of the British Commonwealth, and the effect thereon of the Statute of Westminster and all that that instrument implies. Without a solution of this problem no satisfactory solution is possible to the four great problems enunciated by Lieut.-Colonel Dening on page 73 of this most interesting booklet.

R.L.B.

SADDLE UP.

By Captain F. C. Hitchcock, M.C.

(Hurst & Blackett, Ltd. Price 10s. 6d. net.)

This book, of some 300 pages, contains most of the essential information in *Animal Management* and *The Manual of Equitation*, put together in very readable form and from a civilian point of view. It also includes useful hints about hunting, but does not touch on polo, show-jumping or the care of horses abroad. It is illustrated with several excellent photographs of hunting and jumping, and a number of diagrams.

The first chapter explains what to look for in selecting a horse and would prove useful when choosing a charger. There follow several chapters on the correct methods of riding and jumping, which are in nearly every particular those taught at the Army School of Equitation at Weedon. Useful hints are also given on the elements of instruction. The chapter on the care of the horse, though short, is fairly complete, and contains some remarks on feeding off ground-level, which are new from an army point of view. If introduced they might lead to saving in stable fittings and their maintenance. A chapter on the side saddle explains fully the correct seat, but attributes the well-known superiority of a woman's " hands " to feminine magic, whereas the more usual explanation is perhaps the additional strength of seat gained from the pummels. There are two useful chapters on bitting and gear, which include clear explanations of the use and fitting of martingales. An excellent chapter on hunting gives advice on kit and procedure seldom found in print, going into such details as the correct method of carrying and handling the whip, and the " do's " and " don'ts " of putting on spurs. A final chapter on children's riding is followed by a number of appendixes on terms used in stable management, equitation and hunting, maps showing the location of hunts, hunting seasons and stable tips.

The subject is treated in a simple way and theoretical discussion is avoided. The author has written primarily for the impecunious novice, who wishes to keep a horse on hire for an occasional day's hunting.

If any criticism of the author's instructions is made, it might be directed against the following points. Though holding the stirrup on the ball of the foot may be preferable in the very early stages to facilitate a correct position in the saddle, it is considered that later comfort, appearance and safety are all ensured by placing the foot well home in the iron.

Perhaps not enough emphasis is laid on the necessity for body suppleness, which can best be produced by various exercises, such as touching the toes and bending the body forward and backward on the horse. One of the commonest faults in riding is stiffness. In jumping practice and instruction, it would appear preferable in the early stages to encourage confidence and safeguard the horse's back teeth by grasping the front of the saddle or the martingale strap rather than the reins.

As regards gear, the author appears to have a prejudice against studded bridles. Though the buckled sort look definitely wrong, a studded bridle is often useful for trying a variety of bits and, if properly made, is hardly distinguishable from a sewn one. Its use may save a lot of time, trouble and expense. He also advocates at least beginning to hunt in " rat-catcher " turn-out as being absolutely correct. Even if this is strictly true, it is considered that the more orthodox top hat and black coat will be found more practical, safer and as economical in the long run. Even the thickest " rat-catcher " coat is not as weatherproof as a black one and the hunting " topper " is probably better in compression than the stoutest " bowler."

In the glossary of terms in Appendix A, the calkin is described as being suitable for the hind shoes of draught horses. It should be remembered that they are also extensively used on hunters, with the object of preventing slipping and giving foothold for jumping.

On the whole, the advice given and principles enunciated are excellent. This book should prove invaluable to the beginner or one who has been away from horses for some time

P.A.C.

WILLIAM THE CONQUEROR.

By HILAIRE BELLOC.

(Peter Davies.)

This is another volume in the excellent 5s. series produced by Peter Davies, and Mr. Belloc writes in his own usual attractive way. Only, one gets an impression that the known facts are scarcely enough for any real analysis to be made.

The author traces the early history of Normandy to show the power which enabled William to organize eventually his large invading army, and he gives a most interesting study of the story of Edward's promise to him of the crown and later of Harold's oath, reputed to have been taken over holy relics. He points out that the oath or the promise was not the really important matter: what really influenced outsiders was that Harold did homage to the Duke. In those feudal times, when the absolute right of a ruler to his country as his own personal property was recognized, this homage was looked upon as binding.

There is a grim picture of the conditions in England, of the corruption of the Church, of the murders and intrigues of the usurping Danish ruling families and of the sons of Godwin, resulting finally in the seizure of the crown by Harold. Cruel and ruthless, he was a fine soldier, and his rapid march to the north against his brother and Hardrada was an astonishing performance. After success there, he only just arrived in time, and only with part of his force, to deal with William and his mercenaries. The account of the battle is interesting, though of necessity vague, as little is known definitely. The author differs little from the traditional story. The battle was, however, decisive, and William was almost at once in control of the country. His difficulties are clearly shown. His own followers expected riches, land and loot at the expense of the natives: William wanted a contented native population. It is perhaps a pity that the author has devoted so little space to all the fighting, legislation and administration by which William settled the country: more details of this period at the expense of space devoted to the early history of the Continental "duchies" might have made the book of greater interest to the average reader. The author does produce, however, an interesting analysis of Domesday Book, and points out errors into which most historians have fallen. From a study of the acreage under cultivation, he confidently deduces that the population of William's England was more than four million and less than six million souls.

This is an interesting study which should add to the reputation of this series.

H.G.E.

SURVEY OF INDIA.

GENERAL REPORT.

1931 to 1932.

Published by order of Brigadier R. H. THOMAS, D.S.O., Surveyor-General of India.

Perhaps no department not actually abolished has been hit so hard by the retrenchment policy as the Survey of India. The makers of maps, on which efficient administration depends, are sure to suffer most under our system! It has been reduced, as the report puts it, to a "maintenance basis."

The net actual expenditure, which in 1931–32 was Rs. 41½ lakhs, has now been reduced to Rs. 21½ lakhs, and the establishment of superior officers from 63 to 36, with a corresponding reduction of other ranks.

According to the recommendations of the Curzon Survey Committee of 1905, the whole of India should have been resurveyed on the 1-inch scale by 1930, but even after a series of scale reductions below 1 inch, only half the work was completed by 1925. At the date of the present report there still remained 755,585 square miles to be done, while only 14,434 square miles have been revised since 1905.

The net result must be that the maps of India, of the new series, many of which are now out of date, will become of little value unless some action is taken to bring the department up to strength again.

The usual summary of the work of the different parties is given, together with tables showing out-turn and cost rates of survey on various scales. Since the report of 1930–31 these tables have been divided so as to show the cost of fieldwork and the cost of computation and fair mapping separately. This is an improvement.

One of the survey parties is now entirely devoted to air survey, its chief field being the North-West Frontier, the R.A.F. supplying the photographs.

A new graphical method of plotting from air photographs is described in the appendix to the report by Captain Crone, R.E.* It is intended for application to ground which, for political reasons, cannot be visited or flown over, but can be photographed obliquely from a distance, a few intersected triangulated points only being available. The resulting map, a specimen of which is reproduced, with the exception of some dead ground not reached by the camera, appears most complete as regards detail and contours. The scale is a little larger than 1 inch. The contours have been sketched in from the photographs with the aid of a stereoscope. Its accuracy it is impossible to judge of, and could only be ascertained by actual checking on the ground. However, in the limited conditions it is, perhaps, the best that could be procured, and certainly better than no map at all. This method should be much appreciated for frontier operations where expeditions often had to enter country which had never really been mapped at all.

In a different field, namely the application of air photography to large-scale mapping for revenue purposes in the plains of Bengal, a description is given of the "Independent line method of rectification of air photographs." It is said that the cost by this method is less by Rs. 62 per square mile than the ground costs of survey would be.

H.L.C.

CAN WE LIMIT WAR?

By HOFFMAN NICKERSON.

(Arrowsmith. Price 8s. 6d.)

This is a remarkable and interesting book in which an historical analysis is attempted to ascertain the cause of wars and the conditions that have limited them in the past. The author considers that war is inevitable, and he comes to this conclusion as a deduction from historical evidence. Quarrelling is an instinct of man and cannot be eradicated, as it is part of his nature, together with an inborn love of danger and risk. The necessity for police is due to the fighting propensities of man —they protect the individual against the depredations of other individuals, so we must have armies to protect us against the aggression of other countries. People who see nothing wrong in maintaining a police force often object to armies—this is quite inconsistent. The practical problem then is not the abolition of war, which is impossible, but keeping its destructive effects within bounds. His conclusion is that modern democracies are far more war-like and ill-adapted to deal with things, as they are at present, than the old autocracies. "The present writer suspects that the worst bunch of autocrats known to history—say Nero, Heliogabalus, Cæsar Borgia and Louis XV, given the Europe of 1919, would long ago have mustered enough collective intelligence and good-will to make something of it." Democracy exasperates conflicting nationalisms instead of reconciling them. The essence of democracy is to gain the votes of the people by alternately raising popular passion and cringing to it—no one has the courage to acknowledge this is the most fertile cause of wars, all they do is to say that the cure for the ills of democracy is more democracy.

The politicians everywhere tend to play a shortsighted game, looking only to the next election. Political democracy with its creed of liberty, equality and fraternity has never been a unifying force, often it has not even proved a tolerable form of government. The only hopeful thing about it is that it appears, for the moment, to be under a cloud.

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*See also *R.E. Journal*, September, 1933. p. 480.

Though we are regaled with tales of the dreadful frightfulness of the next war the author does not believe in this. He argues that Germany, the originator of frightfulness, was defeated largely through the adoption of this method of warfare. Frightfulness in war, unless it is an immediate and overwhelming success, does not, in the long run, benefit the country that adopts it. He believes, too, that the case with which an enemy can bombard cities from the air is much exaggerated, since anti-aircraft defence has become so effective. It will at least drive the attackers to such a height that they can neither see their objective nor carry bombs which would do much harm even if they did reach their mark. The aeroplane is no exception to the law that to every new device a counter can, in time, be found.

A chapter on "Disarmament Policy and Politics" gives a very good summary of the various treaties which have been made and international conferences held since 1919 relating to the prevention of war and disarmament, with some scathing remarks on the results. In practice each country proposes to abolish weapons of which it possesses none, and ends in making bad matter worse. Bolshevik Russia is the only power that has advocated the abolition of armies, for the reason that in countries without an armed force it would be much easier for her to promote revolutions to further her pernicious purposes, where there was no means of restoring law and order. Not only do international conferences fail, but they often create ill-feeling among the members.

Human relations between individuals are much more kindly now than they were, say, in the sixteenth century, yet, notwithstanding this, our time has seen the greatest mass slaughter that has ever been. Cannot this sentiment be translated into relations between nations? Fanatical nationalism for ever stands in the way. The only hope in the author's opinion is a reunited Christendom, but the obstacles are very great. "Local interest, inertia, routine and the rubbish of dead tradition block the way." Only religion can resolve our discords, we must restore the Universal Church or perish. This is such a big order that it seems to us the solution is a long way off.

While the conclusions on such a great subject may seem unsatisfactory, the book is of considerable interest. As the writer is an American, we have an opportunity of seeing ourselves as others see us—which is not without its good points.

H.L.C.

THE PILL-BOXES OF FLANDERS.

The story of the defence of the Ypres Salient against terrific odds, through four years of the fiercest fighting the world has ever seen, is one that will be told and told again as long as Britain's manhood retains its pride in courage and endurance.

But nothing could bring more vividly to the mind of the younger generation of to-day a sense of the appalling conditions of warfare in which this military miracle was achieved by their fathers and their elder brethren than a visit to some of the still remaining "pill-boxes" in the Salient.

The "pill-boxes," so named by the British soldier, were reinforced-concrete structures built by the Germans in vital and carefully-chosen positions. Originally conceived as shelters for supports and reserves, they were later used as machine-gun defences. They were capable of withstanding even a direct hit by a 6-in. howitzer, and in most cases they were quite unaffected by shell-fire.

Against these almost impregnable strongholds the British counter-attacks in the Salient were launched from water-logged and ruined trenches, from shell-holes and quagmire. And the success of such assaults, delivered under such conditions, must seem to be against all the conceivable probabilities of war. Yet many of the "pill-boxes" were captured and are still standing to-day as memorials to the indomitable spirit and fighting qualities of the British infantry.

With the consent of the Belgian Government, some one hundred and eighty of

these historic relics have been preserved by the efforts of Toc H and the British Legion. Much devoted work has been given to the task of identifying them and of carefully gathering the facts of their individual stories. And the results of this labour of love have now been set forth by Colonel E. G. L. Thurlow, D.S.O., in a small volume entitled *The Pill-Boxes of Flanders*, with an introduction by General Sir Charles Harington, G.C.B., G.B.E., D.S.O.

The book is published for the British Legion by Ivor Nicholson & Watson, Ltd., 44, Essex Street, Strand, W.C.2, at 1s. net. Illustrated with small scale maps and photographs, and with a valuable large map of the whole of the Ypres Salient on a scale of 1 : 40,000, this little volume is a guide with which any intending visitor can locate and identify the " pill-boxes " and learn the stirring story of each of them.

GYROSCOPIC STABILIZATION OF LAND VEHICLES.

By J. F. S. Ross, B.SC.

(Edward Arnold & Co. 172 pp. Price 14s.)

It is now a quarter of a century since Louis Brennan demonstrated that automatic stability of a monorail car could be produced by means of gyroscopic action. His invention was described in *The R.E. Journal* of June, 1907. Further advances, notably in Russia, have since taken place, but, so far, no completely satisfactory solution of the practical problems involved appears to have been found. The writer of the book under review makes no attempt to solve these problems, but does investigate, very clearly and methodically, the theoretical side of the question. He contends that the initial attack upon a dynamical problem of this sort should be made analytically, rather than experimentally. It is even possible that, had the underlying principles been more completely understood at the very commencement of the experiments, advances might have been more rapid, and financial obstacles less formidable.

The author shows that, before real stability can be hoped for, six separate operations must be carried out :—Both precession and nutation must be damped in both car and gyroscope, and both these components must be automatically restored to their central positions. It may certainly be due to under-estimation of the importance of one or more of these six objectives (especially the damping of nutational oscillations) that smooth running has not yet been achieved. He shows that success is theoretically impossible (or at all events unlikely) unless arrangements can be made to apply, to the mounting of the gyroscope, a stabilizing couple which is proportional to the sum of at least three variables. In the choice of these, however, a certain latitude exists. He carefully selects three suitable variables, and goes very far towards showing that it should be perfectly possible automatically to regulate the supply of stabilizing energy in accordance with the law that his choice demands. The cost of the experiments that would be required to overcome the purely practical difficulties would certainly be high, but there seems to be no real reason why some future generation may not look back upon double-rail traction as " antiquated and clumsy," or even, as is indicated in the preface, regard it in the same light as we now regard the tricycle —" a means of conveyance for invalids and eccentrics."

Experiments and past patents have chiefly been directed towards the production of large high-speed passenger cars, but the military significance of a far less ambitious type of vehicle must not be overlooked. The monorail has certain obvious advantages when it is a matter of spanning that " last mile," which must always separate the occupants of a defended line from their road transport. Anyone interested in this problem would be well advised to study this short treatise, which presents the underlying problems very clearly. Mathematical analysis is unavoidable, but the simplified equations, and their rather neat graphical presentation, should not be beyond many R.E. officers.

E.F.T.

MAGAZINES.

REVUE MILITAIRE SUISSE.

(*July*, 1933.)—1. *Un essai de liberté d'action en manœuvres.*

Colonel Diesbach gives an account of manœuvres carried out under his orders in 1932. He insists on the importance of continuous operations in preference to a series of independent set schemes. Moreover, manœuvres should resemble actual warfare as nearly as possible, that is, they should be carried out slowly, so as to give time to commanders and their staffs to do their work properly.

An interesting point that he raises is that the Swiss artillery will never be strong enough to take up the role ascribed to it in other countries. It will be powerless in the offensive: it may be of use in the defensive, but it will never be a deciding factor.

Colonel Diesbach finds the staff too slow in issuing orders. The orders, when issued, are perfect in wording, but they are far too elaborate.

2. *Mesures propres à assurer une meilleure protection de l'armée.*

Lieut.-Colonel Petitmermet suggests that modifications should be introduced into the military penal code to deal with offences committed by civilians in war-time.

3. *Les tirs de l'artillerie.*

In this second article, Major de Montmollin deals with various subjects, such as the character and object of gunfire, the nature of ammunition to be employed, the expenditure necessary, the duration of fire, and the manner of carrying it out.

(*August*, 1933.)—1. *Offensive et défensive terrestres.*

General Rouquerol gives his ideas as to the respective values of the offensive and the defensive. It is almost certain, from the ideas now prevailing, that governments will not hesitate to reply to a threat of war by mobilizing millions of men, as in 1914. Prior to 1914, the offensive was considered to be the only form of warfare likely to bring victory. The Great War did not confirm this idea. The writer mentions the many French offensives that brought no appreciable gain, but only heavy losses in men. As an example of a successful defensive battle, he mentions the action of the 4th French Army on the 15th July, 1918. A German attack was known to be imminent. The French front line was holding a line known as the "Main de Massiges." This line was now held by a single battalion: the rest of the defending force having fallen back on a strong line of resistance three to four km. in rear. As soon as the enemy artillery opened fire, the single battalion fell back to the rear position. When the German attacking force reached the empty trenches, they were subjected to a terrific and accurate bombardment which caused very heavy losses. The French were able to retake the line with comparatively little loss.

2. *Assurance militaire. L'origine du dommage assuré.* Lieut. Schatz. An article on health insurance for soldiers.

3. *Les tirs de l'artillerie.*

Major de Montmollin concludes his article on artillery fire, distinguishing between the various kinds of fire employed. He considers, for instance, that a rolling barrage is too wasteful of ammunition to be adopted by the Swiss artillery.

(*September*, 1933.)—1. *Principes réglant l'organisation des bases de feux dans l'infanterie.* Colonel Roques.

The *base de feux* consists of the guns and machine-guns that are used in supporting and flanking an infantry attack. In a battalion, the machine-gun company forms the main part of it.

In a battalion in attack, the *base de feux* will be under the orders of the battalion

commander; but the machine-gun company of the reserve battalion or battalions will come under the orders of the regimental commander. As a rule, the regimental guns and machine-guns will fire in the intervals between battalions, but on occasions they may have to fire over their heads.

2. *A propos de l'enseignement du tir.* Colonel Lederrey.

The conditions on the field of battle are such that the soldier will fire quickly: he should, therefore, be instructed accordingly in his course of training. But the writer maintains that the slowest shots are generally the best, and, although it may seem paradoxical, the same slow shots come out top in rapid firing and even when using field targets. The moral of this is that men must be taught to fire accurately before they are taught to do so rapidly.

Another point that the writer stresses is the necessity for men to be taught to fire kneeling. It is obvious that it may be necessary to fire over standing crops or in deep snow, and it should not be necessary to expose oneself as a target by standing up to fire.

3. *La peur de la troupe.*

Lieut. de Senarclens gives a series of instances showing difficulties that an officer may have to face in enforcing discipline. They are instances of insubordination, in circumstances in which the officer who has to deal with it is placed in a quandary.

The writer considers that, nowadays, the discipline of the service is less severe than that of the office or workshop. He suggests that, in schools for officers, a course should be given by specialists on the psychology of the soldier.

4. *Assurance militaire.*

In this second article, Lieut. Schatz states that every man should be carefully examined medically each time that he is called up for training. Under present conditions he is not examined by the medical officer unless he reports himself sick.

A.S.H.

RIVISTA DI ARTIGLIERIA E GENIO.

(*June*, 1933.)—1. *Il Piave.* An account of the battle of the Piave, by General Alberti, gleaned from foreign sources.

In the first half of June, 1918, Austria had collected on the Italian front the pick of her army, consisting of 630 battalions of infantry and 1,327 batteries, besides other arms, in preparation for a great offensive. Italy had, at that time, the support of only two French and three British divisions: she had sent a division to Salonica and a corps to France. Her army on the Austrian front consisted mainly of 49 divisions of 13 battalions apiece.

Marshals Conrad and Boroevic decided on a general attack on a front of 150 miles, distributing their forces along the whole front, and allowing for a very small reserve. They were confident of being able to push back the Italian army as far as the Adige.

The Austrian attack was launched on the 13th June. On the 15th came the first signs of failure. By the 22nd the failure was complete, and the Emperor left the front, to return to Vienna. On the 23rd a general retreat of the Austrian army commenced.

The Austrian losses in this battle totalled 18,000 killed, 91,000 wounded, and 39,000 missing; whilst the Italian losses amounted to 8,000 killed, 29,000 wounded, and 47,000 missing.

2. *Il calcolatore per il tiro da costa.* (N.C. and V.C.)

3. *Convenienza e limiti dell' impiego dei gasogeni negli autoveicoli militari.* By Major C. Amione.

The high cost of petrol and the necessity for being independent of foreign supplies have encouraged the study of other sources of fuel for mechanically-propelled vehicles. The writer here discusses the pros and cons of using gas obtained from wood charcoal as a propellant.

The conclusions he arrives at are that gas may be suitable for motor vehicles in the

back areas, but not for the front line. The government has arranged a system for working forests in rotation, so that the country will not be denuded of its forests when a heavy demand for charcoal is made.

4. *Caratteristiche di impiego dell' artiglieria jugoslava.* Capt. Raudino.

5. *Sul collegamento goniometrico parallelo.* Capt. Armellini.

6. *I ponti ferroviari durante la guerra.* Capt. Leonardi.

The writer gives some details of the destruction and the repair of some of the larger railway bridges on the Italian front during the Great War. The article is illustrated by seven clear photographs that give a good idea of the amount of damage done. The largest portable steel girder in use in the Italian army was the " Eiffel " girder of 30 metres span. The writer considers that this span is insufficient, and that 50- and 60-metre spans should be provided.

(*July*, 1933.)—1. *Impiego di un reggimento d'artiglieria pesante campale nell' attacco in terreno libero.* Colonel Laviano.

2. *Le distruzioni nell' ultima guerra e nel futuro. Loro influenza sulle operazioni campali.*

Capt. Pietravalle begins with some general remarks on demolitions in war-time. He mentions some of the structures that can, in certain circumstances, be destroyed, such as impounding dams, river-protection works, water-supply mains, power stations, food depots, road junctions, bridges, road and railway tunnels, etc.

He next quotes instances of the success or failure of demolitions during the World War. If the Belgian railways had been more thoroughly destroyed at the beginning of the war, Von Kluck's 1st Army's rapid march on Paris would have been rendered impossible.

On the Eastern front, the demolitions carried out in October, 1914, under Ludendorff's orders, were so thorough that the Russian army lost contact entirely with the retiring German 9th Army. Ludendorff gave it as his opinion that no modern army can operate at a distance greater than 120 kilometres from railhead.

In the final German retirement on the west front, in 1918, the allied advance was held up by the thoroughness with which roads and railways had been destroyed and the whole countryside devastated. A French General wrote: " If the enemy had continued his demolitions over a depth of 40 or 50 km., all important operations would have been held up till the spring of 1919."

The writer thinks that, in future wars, demolitions will not be limited to an army in retreat, but that a systematic destruction will have to be planned against works in rear of the enemy's lines. This work will be carried out by aeroplanes, not dropping bombs, but dropping small parties of men with explosives, who will destroy rolling-stock, permanent way, and such bridges as have not been specially guarded. Such parties will, of course, have to be sacrificed as prisoners of war.

3. *Aggiustamento in alzo in base alla misura delle deviazioni esaminato col calcolo delle probabilità.* Captains Cavicchioli and Morricone.

4. *Un metodo di colata di palafitte in cemento armato esperimentato nella costruzione del portile di Sirte (Tripolitania).*

Capt. Valdiserra describes the construction of a reinforced-concrete jetty in the Gulf of Syrta, to replace a wooden pier that had been carried away in a storm in 1929. The work was carried out in three months. The method adopted was somewhat similar to that described by Colonel Haswell in an article in *The R.E. Journal* of December, 1931, but it is claimed to be more economical, and the loss of a special casting at the bottom of each pile was avoided.

The jetty was 84 metres long and 4½ metres wide. The piles were circular in section below mean sea-level, and octagonal in shape above water: this form facilitating the connection of the bracing. The method of construction is described and is made clear by five illustrations.

5. *Nota sulle polveri di lancio delle armi automatiche e delle armi portatili.* Capt. Calvitti.

6. *Sintesi delle caratteristiche militari del terreno delle grande manovre* 1933. (G.C.)

(*August–September*, 1933.)—1. *L'artiglieria italiana durante e dopo la guerra europea.*

General Montefinale, Inspector of Artillery, describes the work done by the Italian artillery, and its development, during and after the war with Austria. He deals with the duties of the artillery from the commencement of the operations, and gives his opinion as to its deficiencies and mistakes, with a view to remedying them in the future.

2. *La relazione Marconi sulla propagazione delle micro-onde.*

Lieut.-Colonel Gatta discusses Marconi's recent experiments in which he showed that micro-waves could be transmitted over distances considerably greater than that between two stations that are within each other's range of view.

3. *Le esercitazioni di grandi unità nelle Langhe.*

4. *Sulla penetrazione dei proietti.* Captains Cavicchioli and Ravelli.

5. *La trasmissione delle immagini e la sua utilità militare.* Lieut.-Colonel Ravazzoni.

After describing briefly the earlier methods of radio-transmission of pictures, the writer deals at some length with the modern system of the photo-electric cell. The transmitting and receiving apparatus are described, as well as the various methods for synchronizing them.

Radio-transmission could be used in military work for sending illustrations, sketches, reports, dispatches, etc. The teleidographic apparatus will transmit up to 300 words a minute, thus permitting a considerable reduction in the staff of manual operators. Lieut.-Colonel Ravazzoni suggests that firms specializing in this class of work should try to design a portable plant suitable for work in the field.

6. *L'accensione elettrica delle mine nei vari eserciti.* Capt. Izzo.

A description of the exploders in use in various armies, the different systems employed and their defects. A number of electric fuses in common use are described, and the special precautions that should be observed in their use are mentioned. Calculations are given. In civil work it is laid down that, to be on the safe side, three times the minimum current necessary to fire a charge should be used.

7. *Le prime glorie dell' aeronautica italiana ed il contributo degli artiglieri.* Lieut.-Colonel Morelli.

TECHNICAL SUPPLEMENT, SEPTEMBER, 1933.

1. *Sul calcolo della traiettoria per archi successivi.* Lieut.-Colonel Bruno.
2. *Specchi per proiettori.* Lieut. Martinez.
3. *Il contributo del Saint Robert al progresso della balistica esterna.* Major Argan.
4. *Contributo al calcolo dei ponti di circostanza.* Major Del Bello. Lieut. Betocchi.
5. *Vade mecum di balistica interna.* Capt. di S. Secondo.
6. *Effetti d'urto nei grandi massi di calcestruzzo.* Major de Matteis.

A.S.H.

REVUE DU GÉNIE MILITAIRE.

(*July–August*, 1933.)—1. *Les fêtes du tricentenaire de Vauban.*

An account of the celebration of the tercentenary of the birth of Vauban, held in Paris on the 30th May. Speeches by General Belhague (Inspector-General of Engineers) and by M. Daladier (President of the Council) are recorded in full, giving an account of Marshal Vauban's life and work.

2. *Les premiers jours de l'école d'application de l'artillerie et du génie de Fontainebleau.*

General Goetschy gives an account of the first batch of officers who attended the school of instruction at Fontainebleau, from December, 1871, to April, 1872. This batch had not completed their studies at the school at Metz when the latter was broken up at the outset of the Franco-German War, and they served with their units through-

out the war. Their studies at Fontainebleau were carried out in an atmosphere of gloom and discomfort: they were subjected to restrictions more suitable to cadets than to officers.

Eventually, considerable improvements were carried out to the place. Fontainebleau remained the school of instruction for both sappers and gunners until 1912. After that it was retained for gunners only, the sappers being transferred to Versailles.

3. *Considérations sur l'influence de la vitesse dans la guerre moderne.* Capt. Fadeuilhe.

In this last article of the series, the writer deals with the employment of sappers in mechanized units. He first discusses the transmission of messages and the merits of wireless telegraphy and telephony and of short and ultra-short waves. The best methods of communication between the headquarters of a mechanized unit and other units, and also with aeroplanes, present a difficult problem.

Next we come to the crossing of rivers. Here the increase of weight due to mechanization necessitates the use of very heavy bridging material. Are the advantages of speed to be thrown away when a force is held up by a river? The writer sees a great future for the amphibian tank, and, as regards a suitable material for floating bridges, he considers the British Vickers-Armstrong-Straussler equipment of folding-boats is the best type for general use.

Other matters that sappers must be prepared to deal with are the crossing of deep ditches, roadmaking and mining, all of which require special equipment.

4. *Sur le front du Grand Atlas marocain.*

Capt. David gives an account of the operations that took place in 1931 and 1932, and led to the occupation of the Grand Atlas region in Morocco. The inhabitants, formerly hostile, are now reconciled to the benefits of French rule. The sappers, assisted by infantry and civil labour, have put in some useful roadmaking work, which has helped considerably in the development of the country. The writer suggests that tourists might be attracted to the country by the excellent salmon-trout fishing.

A.S.H.

BULLETIN BELGE DES SCIENCES MILITAIRES.

(*July*, 1933.)—1. *Pages d'histoire de l'armée belge au cours de la guerre* 1914–18. *Opération effectuée le* 9 *septembre* 1918 *par le* 4*e régiment de carabiniers.* By Capt. Comdt. Van Pottelsberghe.

An account of a successful night attack carried out by the 4th Carabineers on a position occupied by the 26th Bavarian Infantry Regiment.

2. *Vauban et la frontière belge.* By Major Delvaux.

According to Vauban's scheme, the Franco-Belgian frontier was divided into five sections, bounded, respectively, by the Lys, the Scheldt, the Sambre, the Meuse, and the Moselle. He was greatly handicapped in his plans by the modifications in the frontier line caused by the treaty of Aix-la-Chapelle, by the peace of Nimègue, in 1678 between France and Holland, and in 1679 between France, Spain, the Empire, and Sweden, and by the peace of Ryswyck.

Vauban was particularly indignant at the cession of Luxemburg in 1698, which created a gap in the line of defence. For France, it proved an irreparable loss, since Luxemburg covered the Meuse-Moselle sector and barred the road to Champagne, *via* Longwy and Verdun. It was the line of invasion followed by the Prussians in 1792, and again in 1914. Vauban considered Luxemburg and Strasburg the two best strong points in Europe. His fears regarding Strasburg were premature, though his views were prophetic.

3. *Le franchissement des cours d'eau.*

In this article, Lieut. Thonnard describes the German operations on the Marne from the 15th to the 20th July, 1918. After the offensive of June, 1918, the Germans held the line of the Marne between Château-Thierry and Dormans. They decided to

start a new offensive, of which one of the objects was to take Epernay and establish a solid bridgehead south of the Marne between Epernay and Château-Thierry. The operation, for which twelve divisions of the 7th Army were available, was to commence on the 15th July.

The equipment available for crossing the river consisted of 330 pontoons with their superstructure, and 59 companies of pioneers formed the personnel. A portion of the troops was to be ferried across: the construction of the bridges was to be started while the ferrying was in progress. Each division was required to construct two bridges or else one bridge and foot-bridges.

The most careful arrangements were made to keep the plan of operations secret, but the Allies (French and Americans) learned all about it and were prepared to meet the attack when it came. The operations are described at some length. The Germans succeeded in crossing the Marne, but were held up, after heavy losses, on a line a long way short of their objective.

4. *Fiches pour l'instruction de la sentinelle.* By Capt. Rigal. A series of twelve sets of instruction for sentries.

5. *Préparation d'une action offensive par l'artillerie.* By Capt. Colsoulle.

6. *L'observation—un cas concret.* Lieut.-Colonel Nonnon.

(*August*, 1933.)—1. *Franchissement des cours d'eau.* (IV.) Lieut. Thonnard.

In this article the writer has collected from a series of French official publications the regulations for crossing waterways. The most important of the regulations quoted are those for the employment of the engineers. These are subdivided into the following heads:—

(*a*) General considerations.
(*b*) Reconnaissance.
(*c*) Dispositions regarding the passage of units entrusted with covering the construction of bridges.
(*d*) Dispositions regarding the construction of bridges.
(*e*) Provision and collection of material. Personnel employed.
(*f*) Preparation of the troops for crossing.
(*g*) Orders for execution of the work.

2. *Vauban au siège de Mons*, 1691. By Major Delvaux.

An account of the siege of Mons by the army of Louis XIV, under the personal command of the sovereign. The siege began on the 15th March, 1691, and the town capitulated on the 8th April. Details are given of the troops employed, and the materials, weapons and ammunition used. It is interesting to note that, at that time, the proportion of besiegers considered necessary to beleaguer a town was ten times the garrison. Vauban reduced this proportion to six or seven times the garrison by his skill in conducting sieges.

In this case, the French force consisted of 25,000 cavalry and 42,000 infantry. The allied garrison of Mons was 6,000 strong. Under Louvois' orders the town was bombarded with red-hot round-shot, a form of warfare that Vauban considered unnecessarily cruel. The defence put up by the Mons garrison was the feeblest put up by any town attacked by the king.

3. *Quelques considérations sur la défense active contre avions volant bas.*

Lieut.-General Van de Putte puts forward a series of arguments in favour of the adoption of a special armament against low-flying aircraft. The various proposals made are:—

(1) The employment of ordinary machine-guns, furnished with simplified correctors, and grouped in sets of four for day work, and eight for night work.
(2) Mounting two or four machine-guns on the same carriage with a common corrector, the whole being mounted on a motor chassis.
(3) Providing machine-guns of 11 to 20 mm. calibre, specially equipped for anti-aircraft work, firing solid projectiles and tracer bullets.

(4) Providing guns of 20 to 40 mm. calibre, firing a projectile with an ultra-sensitive percussion fuse. These would be capable of making a large hole through the wing of an aeroplane.

4. *Organisation défensive d'une position de batterie.* By Capt. Lenders.

5. *Un cas concret de tactique coloniale. Rencontre de petites unités isolées munies de l'armement moderne.* By Lieut. Bayot.

An encounter between Belgian and German colonial troops in East Africa during the war.

6. *Journées d'offensives, les 30 septembre, 1er et 2 octobre 1918 au 1er Chasseurs à Pied.* Lieut.-Colonel Lievin.

(*September*, 1933.)—1. *Journées d'offensive, les 30 septembre, 1er et 2 octobre 1918 au 1er Chasseurs à Pied.* Lieut.-Colonel Lievin. Continued from August number.

2. *Tactique aérienne. L'attaque en vol rasant.* Colonel Desmet.

After mentioning instances during the Great War, when attacks by low-flying aeroplanes proved successful, the writer discusses the pros and cons of this method of attack. The advantages of flying low are: (1) that it is easier to drop a bomb on a given target; (2) that when flying low, a surprise attack can be effected with comparative safety; (3) anti-aircraft artillery is not effective at short-range, while rifle and machine-gun fire have a limited range, and the rifleman or machine-gunner is uncertain at first whether the low-flying plane is a hostile one or not.

On the other hand, the disadvantages are: (1) the risk of the plane striking an obstacle; (2) extra strain on the pilot; (3) difficulty of orientation; (4) nervousness when flying close to the enemy.

Other points mentioned are: the necessity for a bomb with delay-action fuse, and for the surprise to be complete. In the Chino-Japanese hostilities the Japanese lost one plane out of every three, because they kept to an altitude between 200 and 500 metres. For safety it is necessary to fly much lower.

3. *Les zones de sécurité frontales dans les tirs d'artilleries.* Lieut.-Colonel Vermaelen.

4. *La manœuvre d'Afioun Kara Hissar.*

Capt. Levecq gives an account of the disastrous end to the campaign carried on by the Greeks against the Turks in 1922. The political events that led to hostilities between the two countries in 1921 are described briefly. King Constantine attempted to march on Angora in the summer of that year, but failed.

In August, 1922, the main portions of the Greek army were the 3rd Corps (of three divisions) at Eski Chehir, and the 1st Corps (of four divisions) at Afioun Kara Hissar, with the 2nd Corps as a general reserve. This article deals mainly with the force at Afioun Kara Hissar, distant about 300 km. from its base at Smyrna.

Kemal, commanding the Turkish forces, considered August a suitable time for attack, as the Greek force had been weakened by the dispatch of two divisions to Thrace. The Turkish attack opened on the 26th August. The Turks succeeded in forcing a breach between the 1st and 4th divisions of the 1st Greek Corps, and their cavalry made a dash for the railway line, which formed the one line of communication with the base at Smyrna.

The subsequent events spelt disaster for the Greek army, which retreated, a disorganized mob, to its base. About a third of the Greek force succeeded in escaping by sea; 40,000 prisoners fell into the hands of the Turks. One redeeming feature of the Greek disaster was the gallant defence put up by Colonel Plastiras, who commanded a small detachment that covered the retirement of the Greek army.

A.S.H.

WEHR UND WAFFEN.

(*July*, 1933.)—*Anti-tank Defence* (*continued*). This instalment deals with anti-tank defence tactics, which naturally vary according to the form of attack and conduct of the hostile tank formations. The latter in turn is determined by their

equipment. The differing views of the French and British schools on the best method of employing tanks are well known. These views originated in widely different equipment. The French had 5,000 trusty Renaults over from the war, which by improvements, including rubber tracks, they brought up to a speed of 8 to 10 k.p.h. As this tank affords a very unsteady platform, ranges cannot be reckoned with beyond 500 m. for machine-guns and 600 m. for guns. Hence have arisen with the French the slow systematic advance of tanks in closest co-operation with infantry, tank attacks of great breadth but slight depth, and no independent use of tanks, or raids. The British, on the other hand, in the grand style scrapped their old tanks, and started again on a small scale, experimenting with the most modern improvements. They have now tanks doing 20 to 30 k.p.h. on the battlefield. By the perfected springing of their shooting-platforms, they reckon upon sufficient m.g. effect at 1,000 to 1,300 m. and sufficient gun effect at 900 to 1,200 m. Hence the British ideas of the independent use of tanks, their methods of co-operation with infantry, utilizing in every case to the greatest extent the tank's speed and mobility; and hence also tank attacks in great depth and flexible formations, giving scope to good leadership.

In contrasting these two schools, it is well to bear in mind that latterly French ideas on the use of tanks have approached more and more towards British ideas. Anti-tank defence should be based accordingly. Two fundamental requirements for this may be regarded as established, that against an enterprising and skilful opponent a mere distribution of anti-tank weapons among the troops is insufficient, and it is imperative to provide a strictly organized anti-tank defence under the command of one man; and secondly, the conduct of a successful anti-tank defence demands a well-trained reconnaissance system, having at its disposal aircraft, tanks and armoured-cars.—(*To be concluded.*)

Fighting Wagons for Modern Armoured Trains. Capt. Wagner, who is an expert on this subject (*v. The R.E. Journal*, December, 1929, p. 716), deals in turn with the following types :—

For light-armoured trains (1) Artillery end-wagon. (2) Artillery wagon. (3) Trench-mortar and howitzer wagon. (4) O.C.'s and observation wagon. (5) Tender used as O.C.'s and observation wagon. (6) Wagon for infantry.

For heavy-armoured trains (7) Artillery wagon.

As regards the artillery wagons (1), (2) and (7): the total height of (1) is 1·7 metres from the floor, so that the gun has to be served kneeling; its armament consists of a mountain or naval gun, not over 75 mm. calibre, on a pivot and with a revolving armoured turret, field of fire 270°, also two light and two heavy machine-guns. The total height of (2) from the floor is 2·4 metres, as its gun has to fire over the artillery end-wagon. Its armament is the same as that of (1), but the chief object of the two light m.g's in this case is against aircraft, for which they can be elevated to 90°. The gun has all-round fire. The armament of (7) is one gun up to 6 in., two heavy and four light m.g's (the latter chiefly for anti-aircraft work).

Plans and sections are given of (1), (2) and of (4), which has a mast to take an electric signalling lamp, and a frame aerial for wireless. There are also plan and sections of complete armoured trains, which, still referring to the numbers of the wagon types given above, are made up as follows :—

A heavy-armoured train consisting of :—1 to 3 empty flat trucks, (7), (5), engine, (7), 1 to 3 empty trucks.

A light-armoured train having also from 1 to 3 empty flat trucks at each end, and between them the fighting portion consisting of (1), (2), (5), engine, (2), (1).

Full details of equipment and of personnel are also given. These proposals embody the rich experience gained in armoured-train fighting in Eastern Europe since the Great War (*v. The R.E. Journal*, March, 1929, p. 162, and September, 1930, p. 557).

France's Frontier Fortification, by Major Mouths. At the end of 1932, the *Journal Officiel* announced the formation of 39 battalions of Frontier Guards, and of several

regiments of Fortress and Field Artillery. A few months later it was made known that the French frontier, apart from that adjoining Belgium, had for command purposes been divided into four sectors, viz., (1) in front of Metz and protecting the industrial district of Lorraine, and including the greater part of the Luxemburg frontier; (2) south of the R. Lauter; (3) Lower Alsace, or Bas Rhin; (4) Upper Alsace, or Haut Rhin, as far as the Swiss frontier. Of these four sectors the last two are brigadiers' commands, while the first two are major-generals' commands, a fact permitting deductions as to relative importance. Major Mouths takes these two instances as combining to point to the approaching conclusion of Marshal Weygand's new fortifications, for which 1934 had been spoken of as the latest date.

For the nature of the works which are nearing completion the author finds the most likely indications in General Culman's *La Fortification permanente aux Frontières* (*v. The R.E. Journal*, June, 1932, p. 382) and in Lieut.-Colonel Lobligeois' *Réflexions sur la Fortification permanente* (*v. The R.E. Journal*, December, 1932, p. 733), and with these two notable works and worthy of attention he associates certain utterances of another authority, General Chauvineau.

Various sections (supposed) and plans are given, including that of a triangular closed work. The writer's style is so cheery that a specimen of it is worth preserving: "Of permanent fortifications only the smallest bloom in concealment like violets. This is by no means the case with the larger ones, and with the largest even less so. Sooner or later, however well disguised and guarded, their situation becomes known. The French Government has therefore shrewdly stolen a march from time to time by making certain particulars known. Even then it remains always possible that such pronouncements may be of the nature of camouflage, not in its usual sense of concealing or making unrecognizable, but in the sense of misleading, or as Malcolm said in *Macbeth*, 'to make discovery err in report of us.'"

The Cartography of the Country East of Berlin. An historical retrospect of the maps of the Mark of Brandenburg, omitting the large-scale maps made from civil surveys, and confined to scales from 1 in 25,000 to 1 in 1,000,000, so as to bring into prominence the work of military survey. The subject is dealt with under the headings: country maps; special maps; triangulation; topographical surveys; cartographic work; and geological maps. The oldest survey of the Mark of Brandenburg mentioned is that of Professor Kamerarius of Frankfurt, who died in 1581. Upon this survey two maps were based, that of Ortelius in 1588, and that of Mercator in 1608, both at 1 in 900,000.

International Automobile and Motor-cycle Exhibition, Berlin, 1933. Deals in this number only with the motor-cycles, of which it says that, contrary to expectations, this portion of the exhibition called forth as much interest as the cars. It is claimed that, although the number of exhibits was less than in former years, their quality was so high as to give the exhibition a special note, by showing that German motor-cycle manufacture is now proceeding on its own lines, and is already in a position to compete with foreign countries, "even with England, the motor-cycle's motherland." This statement is backed by quoting a paragraph from the London *Motor Cycling*.

Important New Foreign Railways Since the War. The greatest of all these is the so-called Turksib, or Turkestan-Siberian railway, built in 1928–1930, which connects the Moscow-Tashkend railway with the Trans-Siberian railway. Its advantages both military and economic are thus obvious. It is over 1,400 miles long and runs from Arys on the Tashkend railway, *via* Semipalatinsk to Novosibirsk; and from the military standpoint will serve equally well Russia's striving for an outlet to the sea either on the Pacific or on the Persian Gulf.

As regards other Russian railways, the military situation is so poor west of the double line, Leningrad–Moscow–Kharkow–Sebastopol, that the Second Five-Year Plan includes projects for 25,000 to 30,000 km. of line, partly new and partly the conversion of single to double track.

A new line of military importance has been built in Poland. The grant of the Corridor to Poland with its axis running north and south did not fit in with the general trend of the Polish railways running mostly east and west. A railway now runs from the Polish port of Gdingen near Danzic, *via* Bromberg, Hohensalza, and west of Lodz to Kattowitz, the great colliery centre near Königshütte.

(*August*, 1933.)—*Anti-tank Defence* (*continued*). The conditions stated as being necessary for successful anti-tank defence are now applied to the different cases of on the march and in the fight. The series of articles concludes with a carefully thought-out description of the method of dealing with a tank attack which might be adopted by a division fully equipped for anti-tank defence. As so much depends upon the divisional anti-tank defence commander, and as preliminary conditions for the success of the defence are the earliest possible recognition of the impending attack and its immediate announcement to all concerned, distributed as they are throughout the division, it is possible to make out a very good case for the provision of separate anti-tank defence signals, having at their disposal all signal means from motor-cyclist dispatch-riders to wireless. The Signal Service attitude towards such demands, when they have not been foreseen and provided for, is in the opposite direction, viz., the pooling of resources and centralization. The case for separate anti-tank defence signals must be met by the General Staff and decided by them on its merits. War is won by telephones as well as by bayonets, and often those telephones must be provided in a way that in peace would be uneconomical.

Fighting Wagons for Modern Armoured Trains. The final article is devoted to construction and goes into some detail. Capt. Wagner considers this necessary, for he finds that pre-war armoured trains had several grave faults. They were almost without exception built in private shops and special steel was used, so that they were costly things. Nevertheless, they suffered generally from being badly armoured and from unsuitable armament. They were proof against no more than shell-splinters and infantry bullets, which led to its being generally accepted that an armoured train cannot stand up to artillery. To make an armoured train capable of doing so is, after all, only a question of weight, and the author is at some pains to show that the necessary additions can be compensated for by reducing heights and leaving out the superfluous. Neither engine nor trucks need be new. A small type of engine should be chosen, to offer as small a target as possible, and to keep down its weight for the crossing of temporary bridges. The tender, on the other hand, should be large so as to give the train a wide range, and because it is the best place in which to put the O.C.'s post.

For light-armoured trains only trucks with two axles should be used. The first thing is to lay down a floor of 2-in. boards, and to support the floor by means of brackets where the weight of the walls will come. A cheap and good armour consists of iron sheeting spaced 8 in. apart, and filled in with concrete or a mixture of fine gravel and tar. The sides will need bolting together, and the bolts should pass through tubes cut to length as distance-pieces. R.S. joists to carry the flat sheet roof are then bolted to the external walls, and the roof is put on, leaving the necessary openings for turrets. Reinforced concrete 1 ft. thick is used for the gun turret, while the engine is protected by 6 in. of concrete on both sides of the boiler, and elsewhere by two layers of steel sheets.

The importance of making an armoured train in this way lies in its being made out of the simplest materials. The engineers can either carry out the work themselves or superintend construction in small workshops at a time when, owing to war, all large shops will be fully occupied.

International Automobile and Motor-cycle Exhibition, Berlin, 1933. Describes various motor-cycles exhibited. The favourable opinion formed of the position of the German motor-cycle industry is said to have been fully borne out by the results, under severe conditions, of the subsequent three days' Adac-Harz race.

The Present Position of Explosives, by Lieut.-Colonel Justrow. Written to mark

the appearance of a second and revised edition of Dr. Stettbacher's *Schiesz- und Sprengstoffe* (Verlag J. A. Barth, Leipsic), which work by a Swiss expert is compared with the works of the German authorities on the same subject, Dr. Kast and Dr. Brunswig.

The book gives a clear picture of the nature of explosives, the theory of explosion and of detonation proceedings, the origin of the various explosives and their manufacture, also the many methods of determining their composition and properties. This new edition is specially welcome from a military point of view, as it deals not only with all war explosives, ammunition, bombs, torpedoes and mines, but also with "chemical means of warfare," the poison gases.

Lieut.-Colonel Justrow foresees a great future for the most modern military explosive, called variously Pentaryt, Pentrit, or Pentrinit, which has, however, up to the present, not been rendered sufficiently insensitive to be suitable for artillery purposes. He claims for it that, as a coal product, Germany would not suffer by a future blockade of necessary materials for it, as was the case with picric acid and T.N.T. in the last war. The statement as it stands needs amplifying. All three explosives alike are coal products, requiring treatment with nitrates. The difference between the effect of the last blockade and that of the next lies very probably in the fact that Germany has in the meantime provided for the manufacture of sufficient nitrates at home.

Dr. Stettbacher points out one of the greatest explosives problem which is still awaiting solution—and soldiers will heartily agree—viz., how to ensure that ammunition dumps are not quite so easily blown up in future wars as they were between 1914 and 1918.

Important New Foreign Railways Since the War. The great North-South railway from the port of Gdingen to the coal district of Kattowitz is only a portion of a large railway construction programme. Besides this, Poland's new lines, all of the utmost strategic importance, include a line from Warsaw to Cracow, 312 km., of which the centre half, Radom to Kozlow, existed before: Warsaw to Stralkowo, which, through Posen, points at Berlin: Thorn–Miava–Ostrolenka, also directed on Berlin, but equally valuable for defence, being parallel to the frontier of E. Prussia. The writer finds it hard not to be sarcastic about the economic value claimed in Poland of some of the new Polish railways.

Repair of Wire Entanglements. Lieut.-Colonel Lobligeois, of the French Engineers, has invented a shell which contains coils of wire to be scattered when it bursts, so that the defending artillery can replace the wire which the attacking artillery has destroyed.

(*September*, 1933.)—*Heavy Artillery and Anti-tank Defence*, by Lieut. Hereus. The heavy break-through tank, especially the Char 2C, which, in its latest pattern, carries both a 6-in. and a field-gun, makes it imperative that the heavy artillery should be prepared to exchange its present subsidiary role in anti-tank defence for the main role. The heavies must, therefore, be so adapted as to be able to engage tanks at close range, and the same principles will govern such adaptation as governed the construction of the small-calibre anti-tank guns. This means split trails, armour-piercing projectiles, special anti-tank ammunition for flattening trajectories, and self-propelled gun-carriers.

Heavy and Light, or a Universal Machine-gun? It is understood that the question refers to the equipment of infantry only. As such the answer was foreshadowed by the introduction of a light carriage, which, by the stability and precision gained by recoil absorption, converted a light m.g. into a heavy one (*v. The R.E. Journal*, December, 1929, p. 721, and December, 1930, p. 744). There still remained to be solved the problems of cooling and of feed. The solutions now offered by the Solothurn S2–200 machine-gun (*v. The R.E. Journal*, June, 1933, p. 367), a light m.g., converted in the above manner, are:—

(1) It can dispense with water-cooling, even when used for the persistent fire of a

heavy m.g., since it carries an extra barrel, which allows of more frequent changes. The weight of three light barrels is 5·1 kilos against the 7 kilos of two heavy barrels. The change is only a matter of seconds.

(2) No belt or metal cartridge strip is required, the feed being done by means of a fixed magazine, projecting from the left side of the breech, into which clips of 30 cartridges are introduced by hand. It takes 3½ seconds to fire 30 rounds, and the same length of time to re-load. When the magazine is opened for re-loading the old clip is ejected. These clips, charged, are carried in bundles; but a clip can be filled by hand, or cartridges can even be fired after being placed in the magazine without a clip.

It is claimed that the Solothurn S2–200 will satisfy all the requirements for which both light and heavy machine-guns have hitherto been considered necessary for the infantry.

Measurements of Horse-power. The rate of working of a horse, of unknown weight or breed, and on an unknown surface, having served mankind as a standard by which to measure other manifestations of power, it was reserved for an age of rationalization to institute measurements of a horse's power for an entirely different purpose, viz., to make clear to horse-breeders the connection between performance in draught and the bodily shape of different types of horse. Lieut.-Colonel Giesecke describes with photographs three different kinds of apparatus for carrying out these measurements. They are: (1) an American portable apparatus, by Professor Collins, the characteristic of which is that it measures the maximum draught performance over a very short distance; (2) a Dutch fixed machine, by Professor Visser, in which the pull puts a pressure upon the piston-head of a hydraulic cylinder; (3) Boudry's Draught Dynamometer, which consists of a spring, with needle and scale, which by means of two lugs is inserted between mover and object.

These and other instruments for the same purpose are described in the Agricultural Year Books for 1928, from which a pamphlet has been extracted, *Performance Tests on Draught Horses.* It may be worth noting that the foreign horse-power of 75 kilogramme-metres per second works out about 1½% short of our own.

Important New Foreign Railways Since the War deals this month with France and Belgium, and contains a formidable list of new railways (completed or approaching completion) behind the French frontier. These railways fall into groups: (1) Three new lines in Lorraine; (2) three new lines from St. Dié, one to Metz and two through the Vosges, one due east to Schlettstadt, and one north-east to Molsheim; (3) four new lines south of the Vosges; (4) the doubling of a number of single tracks, and in other cases, as between Lunéville and Saarburg, increasing from two to four; (5) improvements, such as second route from Nice to Avignon, to serve the Colonial Army.

The result is that France has, or will have at least, nine double (to four) track railways serving her frontier against Germany, and crossed by three or more lines running parallel to the front.

The writer makes a little wail that, while France was building up all this strategic strength, Germany, under the Hague Convention, was engaged west of the Rhine in the opposite process, pulling up tracks.

F.A.I.

MILITAERWISSENSCHAFTLICHE MITTEILUNGEN.

(*July*, 1933.)—*Prince Eugene as a General.* Two hundred and fifty years ago, Vienna, Europe's bulwark against eastern invasion, successfully resisted the attacks of the Turks and thus saved Christendom and Western civilization from being overrun by Islam. To celebrate an event of such great importance, an Exhibition has been arranged this summer, from May to October, illustrating the political and cultural development of Austria as a Great Power, 1650–1740. The Exhibition is

being held in the Upper Belvedere Palace, which belonged to Prince Eugene, and is named after him, "The Prince Eugene Exhibition." It attempts to give a comprehensive picture of all that contributed to Austria's greatness during the period mentioned; and it was felt only right that this picture should be dominated by Prince Eugene, not only for his greatness as a soldier and as a statesman, but on account of his services to art as patron, collector and builder.

At this moment, when Austria is celebrating her greatest soldier, Fascist Italy, in its efforts to develop the national pride of its people, claims him, together with Columbus, Napoleon, Mazarin and many others, amongst the series of great men of Italo-Romanic stock, from Cæsar to Mussolini. In furtherance of this object and to stir young Italy to emulation, Colonel Bobbio writes of Eugene as a leader in the *Rivista Militare Italiana*, an article here discussed by Lieut.-Colonel Regele.

The writer, in a dozen pages, manages not only to run through a long military career and to bring out Eugene's sterling character, but, by means of the many classical instances which Eugene furnished to the art of war, makes it abundantly clear why Napoleon ranked him amongst the seven greatest commanders of all times, "the study of whose campaigns is the only means of becoming a great captain and of acquiring the secret of the art of war." Certainly Eugene himself bears this saying of Napoleon's out, for he had "the greatest inclination to military study and read the histories of Cæsar and of Alexander with zeal."

Prince Eugene's strength and independence of spirit, together with his marked preference for doing his own thinking (well exemplified at Zenta, where he attacked and destroyed the Turks against the wishes of the Emperor and the Court War Council, who were entirely satisfied to let them retire in peace), prepare the reader for his opinion on councils of wars: "A council of war is useless except when you want an excuse for doing nothing."

Conrad von Hötzendorf and the Question of War Guilt. Field-Marshal Urbanski continues his defence of Conrad against the charge of having worked to bring about the Great War. He says that Conrad was a profound disbeliever in the Triple Alliance, which he called the Tripod Alliance in order to emphasize his conviction of Italy's unreliability as an ally, and of what would happen when the third leg failed. He urged at all times that Italy should be securely bound to Germany and Austria; and, in 1907, went so far as to demand war against Italy unless it gave adequate guarantees. What he foresaw and prophesied came to pass, viz.: that Italy fought against her own allies; but foresight of this sort brings no reward to its possessor, earthly or otherwise, and in this case it resulted mainly in Conrad being stamped in the popular mind as a war advocate and war agitator. It also strengthened the belief that he worked later to bring about the Great War.

Whatever the main causes of the Great War were, a subsidiary, and, at the same time, the immediate cause, was the murder of the heir to the Austro-Hungarian throne, the Archduke Francis Ferdinand, and his wife, on the occasion of their ceremonial visit to Sarajevo, on June 28th, 1914.

That the Archduke's life would be attempted on this visit appears to have been looked upon as fairly certain by Austrians who knew local circumstances, the Bosnian sympathy for Serbia, and the depths of Serbian hatred of Austria. The author says that Conrad, fearing the consequences, had repeatedly expressed himself against the Archduke's proposed visit to Sarajevo, and he considers that this alone will clear him of the reproach of having wished to bring on the war at any price.

Having thus cleared Field-Marshal Conrad of war guilt, the writer clinches the matter by going on to the much larger task of clearing the Central Powers of the same. This he does in one and a half pages, producing only two items of evidence. The first consists of an extract from the description by the French ambassador in St. Petersburg, Paléologue, of President Poincaré's visit in July, 1914, to the Czar, and of his after-dinner speech in which he spoke of "Serbia's very warm friends, the Russian people, and Russia's ally, France."

The other item of evidence is the author's own statement when giving evidence before the Parliamentary Committee of the German Reichstag, charged with investigating the question of war guilt: "I stated on my full word of honour that, during my five years as Chief of the Intelligence Branch, I had never heard nor become aware of the wish or intention to war of a single person or authority, either of our own monarchy or of the German Empire. That, on the other hand, I had been obliged to recognize the existence of a chain of signs, militarily and politically unmistakable, which with increasing clearness forced one to recognize that Austro-Hungary and its ally the German Empire—systematically isolated—were being forced to a struggle for existence."

The sincerity of this utterance is obvious, and it is undoubtedly evidence—and yet somehow it suggests what Hamlet's mother said of the acting, with a slight reminder of the London magistrate who used to ask in court questions like, "What *is* the ace of spades?"

Considerations about the 1916 *Offensive from the Tyrol.* This offensive was planned for execution by the 11th Army (nine divisions), followed as a second line by the 3rd Army (five divisions), which was intended to follow the 11th Army and furnish it with reinforcements where required. The notes are written by the Commander-in-Chief of the 11th Army, General Dankl, and so amplify the account of the Official History. The danger of the plan by which the offensive was carried out by a single army, followed by another for reinforcement, was that, as resistance increased and progress grew slower or ceased, the temptation would certainly occur of pushing the second army into the line. This is precisely what happened on May 17th, with the result that the plateaux, upon which the main thrust had to be made, were divided between the two armies, and the unity of command, which General Dankl says was an essential part of Conrad's original plan, was lacking.

The Austrians fought their way steadily forward until June 8th, when the Italians managed to hold them on the very last heights in the Seven Communes above the Venetian plain.

The Situation on the Lower Piave before and after the June, 1918, *Battle.* The report of a lecture given in August, 1918, to a class of instruction in combat-leading, by the Intelligence Officer of the Austrian Isonzo Army, which is chiefly interesting as showing what a wealth of information it is possible to obtain about the enemy, his composition, strength, disposition, and even about his plans. Hence arises the necessity for laying down the most careful measures of secrecy, and for strictly enforcing obedience. Such measures include guarding against desertion to the enemy, absolute discretion in telephone conversations with the front line, and ensuring that no orders (especially those marked "Very Secret!") are carried on the person. It is doubtful if these measures go far enough back, since deserters from both sides carried over and imparted valuable information on subjects of which they should have been in total ignorance. In position warfare the fog of war wears very thin and can only be kept at the requisite degree of density by good staff work and by discipline.

On the Piave the Intelligence Branch found the value of a river front in diminishing the amount of leakage of information was very noticeable.

Technical Notes on War Bridges, by Lieut.-Colonel Böhm. The author, under the heading of Light Bridge Types, selects for a guide to further development the portable military bridges produced by the British between 1914 and 1918 on the "System Prof. C. E. Inglis, Major R.E." These bridges, averaging 30 metres in span, are, in their different forms from foot-bridge to 40-ton tank-bridge, throughout battle-bridges, *i.e.*, such as can under normal circumstances be built in a carefully arranged short time in forward areas. The article starts for comparison purposes with a short description of the Austrian Herbert System road-bridge, which is also capable of being taken to pieces, in order to show that the first stages of development of the Inglis bridge display the same peculiar characteristics as this widely-known Austrian type, which started its career in 1887.

The Herbert Bridge, Models 1912, 1914 and 1916. In each bay, or bridge, as the case may be, there are two girders, 4·5 metres from centre to centre. Geometrically considered, each girder consists of a row of four-sided pyramids, the apexes of which are joined through from end to end. Each pyramid is 2 metres high, and has a rectangular base 2·5 m. x 1 m. From the apexes of the pyramids hang vertical rods which carry the transoms. The usual span is 25 metres, or the length of 10 pyramids, but it can, of course, be reduced by multiples of 2·5 metres. The complete bridge weighs 36 tons, or 1·44 tons per metre, takes 10 hours to build and carries tanks up to 20 tons.

British Tubular-rod Bridges. The first trials, in 1914, were with assault bridges for infantry in single file, and allowing also the passage of led horses. The bridge itself may be regarded as a Herbert Bridge girder, of sufficient size to allow the passage of troops through it. Characteristic of its construction was the exclusive use of tubes for ties and struts. The advantages of this method of execution, viz., the greater carrying power for less weight of bridge, and the increased rigidity, were so highly appreciated that heavy-bridge types were also brought out on the Inglis system. The assault bridge was thoroughly tried out in the summer of 1915, when, its components having been brought up on two lorries, a bridge of this type was assembled and launched by 20 men in 10 minutes. American engineers in France are said to have reduced the time to 7½ minutes to completion. The pattern was finally approved in December, 1915; since when further development has made considerable progress.

As the foot-bridge, with pyramids 8 ft. long and 8 ft. high, allowed no head-room for vehicles, and after a genial idea to turn the bridge upside down had been tried but found to make construction unduly complicated, the next step was to make the 12-ft. pyramid, to take field artillery and regimental transport, hence also a light bridge.

Another development was when two Inglis bridges were built side by side, supporting a third roadway between them. Here the resemblance to the Herbert bridge is brought out very clearly. This type of light bridge, in spite of certain disadvantages in erection, survived unaltered, chiefly as cavalry bridging equipment, until the end of the war.

After technically examining both light bridges in turn, the writer concludes:—The Inglis light bridges make an excellent rapid bridging equipment, the principle of which by appropriate extension could be made to suit much higher demands. If these bridges had not already proved their worth in war, but were merely proposals for introduction of a new type, there would be many objections to overcome. Much insight is required, as also the pressure of war, to overcome such objections, and finally to carry out constructional types, the value of which is subsequently recognized.

Military Bridges for Mountain Warfare. Lieut.-Colonel Montes, in the *Revista Militar*, claims that the army of the Argentine has solved the problem of a bridging system of standard parts, easily carried and easily put together, for crossing swift mountain rivers where ferries and pontoons cannot be used. He points out that military bridges are not only indispensable when troops, operating in mountainous country, can be followed by motor transport: they may be equally indispensable when the country prohibits the use of wheeled transport. Accordingly, he puts in a plea for bridging equipment to be carried on pack animals; and, incidentally, another plea for mule-paths as against funiculars and Decauville lines.

(*August*, 1933.)—*Who Prepared the Great War?* On the 18th January, 1919, the Preliminary Peace Conference at the Quai d'Orsay was opened by President Poincaré, who said that "the Central Powers, aiming at European hegemony and subsequently at world dominion, had invented the most odious excuses for smashing Serbia to pieces, and thus opening for themselves a way to the East." The writer of this article, Lieut. Handel-Mazzetti, late of the Austro-Hungarian Navy, with good judgment and discrimination, selects this very statement as the one which places

upon Germany's shoulders the whole responsibility for the war. His article is based upon the not unfamiliar argument that the side, which after the event can prove to its own satisfaction that it was less well prepared for war than its opponents, cannot be held responsible for having brought the war about. General Schwarte applied this argument (*v. The R.E. Journal*, December, 1931, p. 753), taking as evidence deficiencies in Germany's technical war equipment in 1914. Lieut. Handel-Mazzetti sets himself an easier task, for he confines his investigation to the navies of the Great Powers, and thus has little difficulty in showing the superior position of Great Britain and her Allies. He does not mention, however, that Great Britain was not included in Germany's declaration of war, and that the number of people in Germany (or, for that matter, in Great Britain) who thought that Great Britain would declare war on Germany was negligible.

At the same time, the writer does not neglect any scrap of evidence of evil design on the part of Germany's enemies, and indeed no article written with the object of clearing Germany is ever complete without (1) the amazing statement on behalf of the Admiralty in the House of Commons early in 1905 that the first thing Germany would know of the outbreak of war, would be to wake and find its fleet at the bottom of the sea; (2) the First Sea Lord's proposal, in 1907, " to Copenhagen the German fleet at Kiel *à la* Nelson."

Finally, the writer introduces other factors besides naval strength, when he says that the political, military, and especially naval foundation of the Triple Alliance in 1914, was as weak as that of the Entente was strong. " This is the best proof that it is a lie to speak of the militarism of the Central Powers as a cause of the war; and also a proof that the Central Powers neither systematically prepared for nor desired the World War."

Rumania's Entry into the World War, and General Alexeieff. Lieut.-Colonel Diakow, from the *French General Staff History*, Vol. VIII, and from Wassilieff's *The Rumanian Front* (Moscow, 1922), has made some notes throwing interesting side-lights. Rumania's price, promised by the Entente, was those portions of Austro-Hungary (Transylvania and the Bukovina) inhabited by Rumanians. From the Central Powers the reward was to have been Bessarabia. Although the thought was bitter to the Prime Minister Bratianu and to all good Rumanians of a " Greater Rumania " without Bessarabia, Bratianu was a firm believer in the ultimate victory of the Western Powers, and there was little doubt on which side Rumania would enter the war; the only question was—when?

Up to the spring of 1916 the various forces acting were: the Entente applying pressure to Rumania to join them; Germany threatening to order immediate demobilization of the Rumanian army; Bratianu trying to stave off the one and appease the other, while seeking the right moment to declare war with minimum danger and maximum profit to Rumania; and finally, the Chief of the Russian General Staff, Alexeieff, who, fearing that the whole Russian front might be turned by an invasion on his unguarded left, Bessarabia, preferred that Rumania's neutrality should be guaranteed. When, in the summer, Brussilow was driving the Austrians back and had reconquered the Bukovina and parts of Galicia, when the Italians were attacking in the Trentino, and the British and French were gaining successes on the Somme, Alexeieff changed his mind and said to Rumania, " Now or never."

Rumania declared war at the end of August; the Russian offensive was held at the Carpathians; Mackensen in a brilliant campaign of less than four months swept Rumania from end to end, gaining vast resources of corn and oil; and, short of an invasion of Bessarabia, all the disasters foreseen by Alexeieff came about, Russia with a vast increase of front and crumbling forces, held fast in the Balkans, with a new foe, Bulgaria.

Reconstruction of the Serbian Army after the Retreat to the Adriatic, 1915–16. Lieut.-Colonel Mühlhofer has compiled from Bogdanovich's *The Retreat of the Serbian Army to the Sea*, and from Italian and French sources, a chapter of the Great War which would have been grist to the mill of the late Admiral Mahan. The story of how the

remnant of a beaten army to the number of 140,000 men with only 55,000 rifles and almost without artillery or machine-guns, reached the coast, and, under cover of the North Albanian Alps, which stopped pursuit, was embarked and removed to peace and safety, the story of how after being rested and healed it was reorganized, re-equipped and trained so as to be able to land a thousand miles away five months later as an army of six divisions, full of fight and desiring only to get at the enemy and free their fatherland, forms a fresh chapter on the influence of sea power on history.

If the parts played by Italy, France and Great Britain were invaluable, the greatest praise still goes to the Serbian Army.

Austro-Hungary's Collapse as Seen by French Eyes. Major Franck, in this article, reviews Moreigne's " The Military Collapse of Austro-Hungary," which appeared as part of the *Revue d'histoire de la guerre mondiale.* In a short review of this nature, it is no doubt difficult to avoid giving the impression of accepting all the praise, and of stoutly rejecting everything which sounds like blame, but this is corrected by Major Franck's summing up of the work as " a very remarkable and thorough study, in which, by a skilful use of all the important literature bearing on the subject, an arresting and for the greater part astonishingly objective picture is given of the interaction of all military, economic and political forces, which brought about the downfall of the Hapsburg monarchy."

Napoleon would have read with surprise Moreigne's statement that " we (Frenchmen) can hardly realize the value and strength to the Austrians of their respect for their oath of allegiance to the Emperor " ; if, indeed, he had not already been deprived of that faculty by the sight of British officers walking about in France wearing the scarlet ribbon of his beloved Legion of Honour.

Points arising in Combat Training, by Major Franck, and *Aids to Troop Training,* by Major Schwarzböck, are full of good sense, but possibly not above the Sandhurst curriculum. Good tips abound, *e.g.,* always bring enemy action into every exercise. The gain in invisibility by being crowded together in a sunken road as against being scattered in the open, does not usually make up for the increased vulnerability. Better risk being seen than spoil your own observation. Do not let your men seek cover only because a machine-gun has started firing, but only when it is directed at them. A full day's training on well-prepared schemes on suitable *terrain,* reachable, perhaps, only by the use of M.T., may be worth a fortnight's work round barracks. For such schemes, preliminary reconnaissance by officers is indispensable. Find time, when on one scheme, to be roughing out the next scheme in your mind.

Major Schwarzböck, who deals principally with the marked enemy and with the use of model-rooms, may be laid under levy for : The model-room should be a hive of activity, and not a museum ; all out-of-date models being removed.

An American Landing Manœuvre tells how a battalion of United States infantry was trained for and carried out a landing on a " hostile " island, Oahu, in the Sandwich Islands, without meeting any resistance ; and this although the garrison possessed aeroplanes and, having seen the fleet arrive, must have been on the alert. The observation stations on land had been blinded by smoke-screens from the attackers' aircraft.

The moral seems to be that even a most difficult operation like a landing can succeed, (1) if every contingency is thought of, and every detail carefully worked out for months beforehand, (2) if the troops selected for the landing are given four months of special and intensive training, including rehearsals.

C'est magnifique, but is it war ? Even manœuvres sometimes have a political side, and it may have been desired to prove that a landing was possible. Information as regards one valuable item is omitted, viz., the number of man-hours expended in staff work for this operation.

Technical Notes on War Bridges, by Lieut.-Colonel Böhm. Treats of the heavy Inglis bridges (12-ft. pattern lorry-bridge and 15-ft. pattern tank-bridge) in the same manner as the last instalment treated of the two light Inglis bridges. Here, in order to obtain head-room, the triangular profile in cross-section had to be changed

to quadrilateral—square in the case of the heavy 12-ft. pattern-bridge, and in the case of the tank-bridge, 15 ft. broad by 13 ft. high.

After describing components and erection, and giving tables of loads and moments, the author sums up that these two heavy bridges are too heavy, and their parts not easy to handle. True war bridges must fulfil much greater requirements. The two heavy Inglis bridges are not simple enough to be spoken of as war bridges. The occasions on which in the course of an average of six hours the erection of such bridges may be possible will be very rare. This bridging equipment will fail completely in cases where open and level sites for assembly are wanting, and where in a short time more than one bay has to be built upon solid intermediate piers.—(*To be continued.*)

Refuse and its Utilization. A distinction between refuse and by-products cannot be easily drawn, since many examples go to show that what is at one time refuse and a trouble to get rid of, may become under different circumstance a valuable by-product. The outstanding example of this sort is pit-coal tar, for very many years the refuse in illuminating gas production and difficult to get removed, having then as its highest use the preservation of wood from decay, and now, a mine of inestimable value in the dyeing industry, for making explosives, and in pharmaceutics (*e.g.*, for aniline, anthracene, alizarin, the indanthrenes; for picric acid and T.N.T.; for naphthalene, aspirin, saccharine, phenacetin, antipyrin, and very many more).

The intimate connection between refuse and by-products was brought out by the war. Before that, one often heard the axiom, "In war, money plays no part." Within certain limits, this saying is not untrue, since for the soldier in war the best is just good enough, and because financial considerations should never affect military measures: but it can be taken to have quite a different meaning, and thus to open the door to the greatest wastefulness. Such wastefulness, however, came to a speedy end, as necessity drove, and in the last years of the war waste was reduced to a minimum, once the lesson had been learned that not only everything utilizable must be preserved, but that even the most apparently worthless refuse might serve some war purpose.

However, all this happened fifteen years ago, and much has been forgotten. It is up to us to train the young soldier to think of the cost of things. It should become part and parcel of himself to handle with the greatest respect all Government equipment, since it is the property of another, entrusted to his care.

Examples of River-crossings in the Mobile Warfare of the First Years of the World War. This book, by Major-General Königsdorfer, has been brought out at the instigation of the Inspector-General of Engineers and of Fortifications. It deals strategically and tactically as well as technically with the following crossings: over the Meuse and the Oise, 1914; over the Nethe for the siege of Antwerp; over the Yser in October, 1914; over the Narev by Gallwitz's army; in July-August, 1915, over the Dniester by the German Southern Army in July, 1915; and finally, with the great crossing of the Vistula in 1915, near Ryczywol. The book also discusses general questions of military bridging. Publisher: Verlag "Offene Worte," Berlin, W.35, price 3 marks.

(*September*, 1933.)—*The Significance of the Year* 1683 *in the History of the World*, by Major Czegka. This article follows an editorial introduction announcing this number of the magazine as a Memorial Number with special articles celebrating the 250th anniversary of Vienna's successful resistance of the Turks, and the defeat of the latter by the relieving armies on September 12th, 1683. Major Czegka prepares his readers for the idea of what it would have meant to Europe if the Turks had taken Vienna, by a quotation to the effect that the great march of the world's happenings has been determined by mighty movements of peoples out of the interior of the European-Asiatic continent towards the West. These movements have come in waves, and sometimes they have met with repulses. They have always been conducted by great personalities, the bearers of the leading idea. Such a wave had broken on Vienna once before, under Solyman in 1529. A greater wave, also under

the banner of Islam, had been broken far west of Vienna, when Charles Martel, in 732, wiped out the Saracens from Spain in seven days' fighting between Tours and Poitiers.

The writer now tells of the events leading up to the third great wave, when, assisted by subsidies from Louis XIV, Kara Mustapha, with an army of 170,000 men, Turks and the Hungarians under Tököly, whom they had conquered, laid siege to Vienna. Rome was their object, as it had also been the object of Solyman a century and a half earlier. It would have gone badly with Vienna and with the troops, only 23,000 strong, shut up there, had not the Pope managed to get allies for Austria, the chief of which were the Duke of Lorraine and John Sobieski, King of Poland. It is interesting to notice in this Austrian account, in distinction from English and Italian accounts, how systematically the part played by John Sobieski is belittled. It would almost seem as if a patriotic Austrian cannot bear the thought that the deliverance of Vienna was in any way due to a Pole; and yet Sobieski was in supreme command of the relieving forces, and the Turkish retreat became general when the Tartars, whom he had in true Oriental fashion bought off, left the field.

This deliverance of Vienna, and indeed of Europe and Christendom, from the Turks, was followed by a series of events all of which had an important bearing on European history. Austria, strengthened by the Treaty of Regensburg, guaranteeing twenty years' peace with France, started to reconquer territories in the East which had been torn from Western civilization since Solyman's adventures. Brandenburg was disassociated from its alliance with France. Russia and Poland made peace through the efforts of the Pope, and Russia was won against the Turks. The crown of Hungary was gained for the Hapsburgs, to be followed by the crown of the Holy Roman Empire, uniting the petty German States and making Austria one of the Great Powers. The Sultan, as a result of the brilliant generalship of Prince Eugene, was so heavily defeated as to become for over 200 years "the sick man of Europe": while the end of the War of the Spanish Succession confirmed England in her position as mistress of the sea.

The Second Siege of Vienna in 1683, a translation from the Turkish. The *M.M.* is to be congratulated upon its enterprise, as well as upon the sporting idea of obtaining their second article on this subject from a Turkish source. The writer is Major Necati Salim, of the Turkish General Staff, who, with the fullest references to all sources of information, tells the story of the campaign, of which the siege formed part, in an article covering over 30 magazine pages. Major Salim, like the writer of the foregoing article, treats the subject politically, but in addition gives a narrative of events, starting in Constantinople. He shows how the second siege of Vienna was a turning-point in Ottoman history, and incidentally he mentions that when the beaten army made its first halt at the Raab, two days after the battle on the Kahlenberg, the leader who was accused as having been the first to give way, Ibrahim Pasha, was executed *pour encourager les autres.*

Points arising in Combat Training. Major Franck deals this month with three subjects: the means of communication in the fight; the time-scale in peace training; and co-operation between artillery and infantry. He is all for orders by word of mouth, and against making the official signs with the arms, which should be done only when the voice cannot carry. Of portable semaphores and other methods of passing orders, like screens or shutters of various colours, he says the Austrians went into the war with what seemed a very good system of this nature, but that it was practically unused. "The fact is that among the foremost fighting troops the runner remains the most indispensable means of communication."

As regards the time-scale in peace manœuvres, he begs for more consideration, and recommends that operations which take time in war, if hurried over in peace training, should at least have the deference paid to them of notice being taken and of some delay being made.

As regards artillery and infantry co-operation, he laments that this is very seldom

practised by the troops; and therefore it requires all the more to be emphasized at ordinary field exercises, at courses and schools. In war, the best means of obtaining it is for artillery and infantry commanders to be together, and that this may be so the infantry commander must choose his battle headquarters so that the artillery commander gets the observation he requires.

Vol. IX of the German Official History. This volume covers the last few months of 1915, so includes the arrival of the Kitchener divisions in France, the British and French offensive in Artois, the French offensive in Champagne, and the autumn campaign against Serbia. It also deals at great length with "The Significance to the Conduct of War of Economics and Armament," and tells the tale of what happened in each of the German colonies, Kiao-chau, Togo, German S.W. Africa, Kamerun and German E. Africa. Light is also thrown upon the pros and cons of the Salonika problem. In a retrospect it appears that the results achieved in 1915 did not give full satisfaction. Land communication with Turkey had indeed been established, but the Russian army had not been put permanently out of action, so that Falkenhayn did not feel his hands free for the decision he was striving for in the West. On the 3rd December, 1915, Falkenhayn proposed to the Kaiser an offensive in Alsace with all available forces, and having Belfort as its immediate objective. But before Christmas he had gone over to the idea of attacking Verdun instead. This he intended as a "bleeding to death battle," and so he carried it out.

Sword and Plough on the Frontier. Dr. Bauer, who writes this article, is the leader of a "Back to the Land" movement. He warns against the dangers of industrialization and of the great increases of town population at the expense of the countryside. In 1870, he says, only one German in twenty lived in a large town. Now, the proportion is one in three. As Dr. Bauer sees the country producing all good things, like healthier citizens, family life, security, permanency, will to defence and loyalty, he earnestly desires to promote schemes by which every man can own his own home, and if that home is on the frontier, so much the better.

The Second Disarmament Conference. Major-General Paschek writes a *résumé* of events from the 11th December, 1932, when the Five Power Conference acknowledged the equal rights of Germany as a leading principle for the Disarmament Conference, up to the 29th June, 1933, when the President adjourned the Conference until the middle of October. Since then, Mr. Henderson has expressed his hopes of obtaining unanimity on the following points: the matter of control; the non-employment of force (at least in Europe); the acceptance of Russia's definition of the aggressor; a uniform militia system; and the abolition of heavy weapons. Against this hopeful programme, the French demand first four "trial" years of the strictest control, to be followed by four years of the gradual abolition of all aggressive weapons. Germany desires that this abolition should take place in the first four years at the same time as all weapons of defence are permitted to Germany.

Determination of the Moments of Inertia of Projectiles. The advantages of the experimental method of determining the moments of inertia of a projectile are reliability, ease, the check it affords on the calculations upon which construction was based, and the discovery of possible defects in manufacture with respect to the position of the centre of gravity.

This article describes, with photographs and diagrams, instruments for the experimental determination of a projectile's centre of gravity and of its moments of inertia, a static balance for the former, and for the latter a cradle on a turn-table. The oscillations of the latter are recorded on a diagram, and deductions are made from a comparison of the oscillation diagrams of the unloaded system and of the system carrying a projectile.

The Commander and War Technics, by Karl Justrow. The writer is an artillery officer, and of high repute in Germany. He has written a book on modern warfare with lessons for the future, but all based on studies of Count Schlieffen's plan. The book is recommended by Lieut.-Colonel Regele, but he thinks it should have said

more about the deficiencies of engineer equipment for the German offensive in 1914. Justrow's idea is that Schlieffen had an insufficient understanding of the nature of the coming war. He thought of it too much as being conducted in the cavalry offensive-spirit, instead of as a matter of strategy and technics. In other words, Justrow implies that Schlieffen's order of importance was (1) tactics, (2) strategy, (3) technics. Justrow himself says that the chief blame for Germany's defeat is to be accorded to the over-estimation of strategy and the neglect of war technics. From which it might seem that Justrow's idea of the order of importance is (1) technics, (2) strategy, (3) tactics. Hence he demands for the commander of the future "a blend" of strategic and technical insight.

F.A.I.

REVUE MILITAIRE FRANÇAISE.

(*July*, 1933.)—Général Loizeau finishes *La manœuvre défensive* with a description of "manœuvring in retreat" and actually of "retreating." It is noticeable that the French are now paying considerable attention to retreat, very different to their manner of only thinking of the offensive before the Great War. It is largely Foch who has brought out the idea that there is no disgrace in retreat provided it is realized that the whole object of war is to defeat the enemy and that at times retreat may be necessary before striking the vigorous blow required. The object of this instalment is to point out that manœuvring in retreat is different from the normal process of retreating; the first may be done although the enemy has not given any pressure to the part of the front where the manœuvre is carried out, while the second is due to some form of success by the enemy. General Loizeau deals with the different forms of retreat concerned, points out how necessary it is to hold the flanks where the enemy has broken through (as stated by Foch in the summer of 1918 on the Kemmel sector), and concludes by showing how retreat may well be part of the general manœuvre of destroying the organized forces of the enemy.

The second instalment of Colonel Bernis' *Essai sur le renseignement à la guerre* appears in this number. He takes two actions in 1870 and 1914, at Metz and at Guise, discusses the actions of Moltke and Frederick Charles in the first and Von Bülow in the second, shows how they were wrong and describes what actually happened. On both occasions the French army was retreating and as a result the German commanders considered that they were driven back and, therefore, that they could push on as fast as possible without collecting more information to start with. At Metz the German leading corps were in considerable danger of being defeated, but were spared by the fact that their corps commanders were of sterner stuff than the French general. At Guise, however, General Lanrezac, commanding the French 5th Army, knew what he was doing and his counter-attack had a considerable slowing effect on the German advance. Colonel Bernis shows how many orders the Germans produced which were of no use when they reached the troops, and explains how difficult reconnaissance is before it becomes really effective in the hands of the General who has to provide these orders.

Capitaine Mousset finishes *De la bataille de la Marne à la course à la Mer* with a description of Castelnau's failure to work round the German right north of the Somme, of the German failure to bring off an attack from Picardy to the Argonne at the same time, and finally, of his own conclusions on this period of the war. Falkenhayn, who had succeeded Moltke, was many years younger than his army commanders and was unable to impress his will on them. Therefore the German plans were indecisive, and consequently failed as Falkenhayn continued to change his mind. With the French, Joffre had learnt caution from the first stages of the war, and now he was unable to carry out his outflanking movements with sufficient width of purpose and so his efforts were also a failure. Looking back on this period, one feels that

neither side had sufficiently good intelligence of the other and that as a result neither were able to attack sufficiently vigorously to drive back the enemy.

Général Golovine begins *La bataille de Galicie en* 1916 in this number. At a conference early in that year, it was decided that the Russians should attack in order to draw as many Germans as possible eastwards; in fact, however, the German attack at Verdun forestalled the Allied programme. The Russians, however, produced an attack in Galicia which, at first, surprised the Germans and nearly held up their offensive in France. General Golovine describes this attack, and how General Brussiloff disagreed with General Alexieff, the Chief of Staff, as to how it was to be carried out. The Russian line in 1916 ran approximately north and south east of Vilna, after the German successes of the previous year; but apart from the position of the Russians, their great drawback was the lack of heavy guns and ammunition. The writer gives tables showing how the Russian guns compared with the German and Austrian; from these tables, one can see how poor a chance the Russians had over any length of time, at least as far as the Germans were concerned.

Réunions et cercles d'officiers, by Commandant Delbe, begins in this number. To the British officer, accustomed to living in a mess, it may seem strange that the French did not begin messes before the 1870-01 war. In fact, in 1863, an article appeared in the *Spectateur militaire* in which the idea of having military clubs or messes was held up to derision. Once, however, these messes started they caught on immediately, and although they are not quite the same as British messes, a great deal is now done for the instruction as well as the comfort of the officer. There has recently been an article in this magazine on libraries, in addition there have been military arrangements for physical exercise, practice with arms, etc., including theatres. Where the French type of mess differs from the British is that they are not confined to one regiment, but take in all arms at any particular station. Some of these messes, or *cercles d'officiers*, are now of a considerable age and are very popular in the French Army.

(*August*, 1933.)—Colonel Bernis continues *Essai sur le renseignement à la guerre* in this number. The object of this essay is to show that the French method of finding out what the enemy propose to do is better than the German method, and the writer chooses the brilliant action of the French about Rheims, in July, 1918, where General Gouraud succeeded completely by holding up the German attack. There is no doubt that here the French had accumulated a number of pieces of intelligence which showed exactly when the Germans were going to attack, and at the same time General Gouraud's method of opposing the attack was thoroughly successful. One would like to be able to feel that the Allies were always equally successful in foreseeing what the enemy proposed to do, but unfortunately there were other German attacks in 1918 which were not resisted with anywhere near such success as July, 1918. It is no doubt true that Napoleon was hardly ever surprised and that on the whole the French method of acquiring intelligence is efficient, but at the same time both French and Germans were liable to fail to have the necessary information at first, and only acquired it later after a good deal of practice in the field.

Chef de bataillon Gras begins *L'offensive sur Colmar en* 1914 in this number. This was an advance of the army of Alsace at the outbreak of the war, before it was broken up to take part in battles further west which turned out to be of far greater importance. To the Englishman, the detail given as to how the 81st Brigade was formed, where it moved, etc., is not of particular interest, unless he happens to know the country. There were three phases during this action, an offensive up to Colmar, a defensive pending the dissolution of the army of Alsace, and, finally, a retreat. In this number the offensive is described and illustrated by a map.

La campagne de Hoche dans les Vosges en 1793, by Colonel P . . . , begins with a description of Hoche when he became a General and of how he was defeated at the battle of Kayserslautern. He was only 25 years old when he was appointed to command the army of the Moselle; next to him was Pichegru, with the army of the

Rhine. Although he had not received much instruction in strategy or tactics, Hoche was determined and improved the troops out of all knowledge in a short time. Unfortunately he did not "hit it off" with Pichegru, and partly as a result was defeated at Kayserslautern. All the same, he attacked for three days and, although he was forced to retreat, the Prussians made no effort to follow him up. When the commissaries of the French national convention covered him with reproaches, he answered them with every sign of achieving victory in the future, even though he had just been defeated, and showed that he had the first quality of a chief: confidence in himself and in his army. After the defeat of the French earlier in 1793, the appearance of Hoche showed that here at last was a real leader to protect France against the Prussians and Austrians who were threatening her.

H.A.J.P.

JOURNAL OF THE BRITISH SOCIETY OF DOWSERS.

No. 1. SEPTEMBER, 1933.

In *The Supplement to the R.E. Journal* for June, 1933, the successful formation of the British Society of Dowsers was recorded. We have now received the first number of the Society's journal. It is at present a modest production of 20 pages, priced at 1s., and contains besides an editorial, notices, and reviews, six articles of varying length, including some hints for beginners.

The longest contribution is "The Cause of the Phenomena of Dowsing," by D. D'A. Wright, F.R.C.S., in which an article is mentioned as having appeared in the *Guy's Hospital Gazette* this year, describing the results of a series of experiments in this subject carried out in the Physiological Department of Guy's. The results are very interesting and worth studying.

For those interested in dowsing, this new Society and its journal offer an easy and economical means of keeping in touch with others of similar tastes, and with the latest developments of what is described as a "neglected natural science."

The publishers are The British Society of Dowsers, Backwoods, Lindfield, Sussex.

P.H.K.

MILITAR WOCHENBLATT.

German Landing Exercises.—The Schleswig-Holstein Pioneer (that is, Field Engineer) Battalion No. 9 of the old German Army was wont to carry out landing practices, and its companies were provided with special technical equipment for the purpose. According to the *Militär Wochenblatt* of the 25th October, 1933, the Stettin Pioneer Battalion, No. 2, of the *Reichswehr* is following the tradition of No. 9. It carried out landing exercises this autumn, of which a short account is given.

The operations were practised in East Prussia, the general idea being that Pillau, the only German port in that province, had been destroyed by air attack, the Polish Corridor was barred, and it was necessary to send reinforcements to East Prussia by sea. The coast is low and shelving, and deep water at least 2½ miles distant. The first operation was to fix the 2-metre line exactly by buoys to mark the limit to which light craft could come. The next was to lay wire cables 100 to 200 yards long to the shore from some of the buoys to selected places where the 2-metre line approached the shore most nearly. The purpose of these cables was for hauling in horse and vehicle boats and barges by hand after they had been towed up to the 2-metre line. The third step was to build light piers at which infantry could land. The last was to construct heavy piers out to the 2-metre line.

J.E.E.

CORRESPONDENCE.

LANDING GROUNDS IN SOUTH ARABIA.

To the Editor, *The Royal Engineers Journal.*

DEAR SIR,

Major Fryer's article in the March issue of *The R.E. Journal*, on the fixing of the positions of landing grounds in Arabia, raises a number of interesting points. In the first place, why should it be necessary to send an officer all the way from England to Aden, a station where there is a Fortress Company R.E., to do a small survey job which one would have expected that any R.E. officer or surveyor could tackle? If the survey course that one does as a Y.O. at Chatham does not fit one to do a job like this, there does not seem much object in making it so full.

Why did Major Fryer prefer the theodolite to the astrolabe? This seems to be *the* job for which the latter instrument was designed.

Is the Tavistock theodolite as good as similar Continental instruments, or at any rate is it good enough for general adoption? One was recently used in my party and not very well reported on. On the other hand, the Wild theodolite is in general use in India and is popular. One advantage that the Tavistock is supposed to have over the Wild is that it can be repaired in the field. Major Fryer, however, did not use his Tavistock in Arabia, whereas both in India and in Canada Wild instruments have been taken down and repaired in the field. The specification of the Tavistock is excellent and one would be only too glad to use an English instrument, but at the moment it does not seem to be as good as the Wild.

Cost rates are always interesting, but they are only useful for purposes of comparison when the same items are included in all cases. It would seem that Major Fryer has omitted all transport charges, although he has used probably the most expensive form of transport. Also £200 seems very little to cover the cost of instruments and the pay of a R.E. Captain as a recorder. Major Fryer has not stated what standard of accuracy he was aiming at, nor what are the probable errors of his results. These are not only interesting for their own sake, but they have a direct bearing on the cost rates. Only five stations of observation are mentioned in the article. If the total cost was £200, the cost per station would be £40 and not £33 as stated. In 1932–33, a party in India in one field season fixed the latitude and longitude of 44 stations at an average cost of Rs. 660 (£50) per station. This includes the move of the party from Dehra

Dun to Burma and return, and also the transport of all the instruments for 1,000 miles on mules in Burma. In this work the astrolabe was used at every station and checked by a transit, with an impersonal eye-piece, at every fourth station. The probable error of this work was 0·41″ in latitude and 0·33″ in longitude (the latter figure includes the probable error in time-keeping of the three clocks between star observation and the wireless signals but includes nothing for personal equation), which is probably better than the standard aimed at or attained by Major Fryer.

Major Fryer states that the use of a tape is the approved method of measuring a base. I think that most officers with recent experience in India would prefer to use the Hunter Short Base. The total weight of this apparatus is 22 lb. and this may sometimes be too much for the transport available. Although it will give a greater accuracy than is often required, its simplicity and the ease and speed with which it can be laid out justify its use on almost all occasions. This has not only been adopted by the Indian Field Survey Companies, but by the R.A. Survey Section as well.

The method used by Major Fryer to record the instant of observation, *i.e.*, to call out "Up" to a recorder who then notes the time on a chronometer, is somewhat crude. It demands the presence of a recorder, not always available but always an expense, and is burdened with the personal equation of two men. No field method can be perfect, but it should not be difficult to improve on this one. One possible alternative is for the observer to start a stop-watch at the instant of observation and then to walk over to the chronometer and to stop the watch at a definite chronometer reading. The chronometer time of the instant of observation is then obtained by subtraction.

I have no personal experience of the reception of wireless time signals, but Major Glennie, who has used them a great deal, writes :—

> "Rhythmic time signals have now been in use for about 12 years and by now one really accurate method of receiving them in the field should surely have been found. Using the standard Mercer chronometer, which is fitted with a break circuit, I am convinced that the best method of receiving is to use the chronometer to break the ear-phone circuit. In this way the uncertainty of the time of coincidence amounts to one second only and there is no personality.
>
> "Major Fryer's method of eye and ear reception may easily result in an error due to personality of 0·1 sec. or more. If a break circuit chronometer is not available, I believe audible reception of the clock seconds using a microphone would be better than a method involving the use of two senses, but I have not tried this. On the few occasions that I have tried the eye and ear

method for gravity work, I have found it far less satisfactory than the break circuit method.

"The method of counting the dots to the bar seems inconvenient and unnecessary. All that is required is to note the time of the first bar (bar 0 in Major Fryer's notation) correct to 0·5 sec. and the times of the coincidences. There is no difficulty about getting the time of the first bar fairly accurately when using a sidereal clock, since one bar in the six will fall nearly on an exact second, and one can work back to the first bar by deducting 0·17 sec. for each minute.

"The coincidence interval with a correctly rated sidereal clock is 72 sec. and then the factor to be employed in Col. 8 of Major Fryer's Table I is 72/73 or 0·9863, but if, as he says, the clock is losing 55 sec. daily, the coincidence interval will be about 69 sec., so that the factor to be used is 69/70 or 0·9857. Col. 8, however, shows that the coincidence interval at the time of reception was 71 sec., so the factor which should be used in Col. 8 is 0·9861.

"A coincidence interval of 71 sec. shows that the clock at the time of reception was actually losing at the rate of rather less than 17 sec. per day. A chronometer which shows an instantaneous rate differing by more than 38 sec. from its mean daily rate is, to say the least, not very reliable.

"Major Fryer has found inert cells unsatisfactory for the H.T. battery. This has also been my experience in India. The ordinary dry H.T. battery obtainable from any wireless dealer is cheaper and lighter than the inert battery and is quite satisfactory in the field. One good quality dry H.T. battery will last six months in the field, using it two or three times daily for time signals."

Yours faithfully,

W. J. NORMAN, *Major, R.E.*

4th October, 1933.

To the Editor, *The Royal Engineers Journal.*

DEAR SIR,

I am grateful to you for allowing me to see Major Norman's letter on my article which appeared in the March issue of *The R.E. Journal*, and for affording me an opportunity of replying to it.

The general trend of Major Norman's letter seems to me to be to the effect that these things are so much better done in another place. Perhaps they are, but my article in the *Journal* was intended primarily to describe individual experiences and technical methods likely to be met with by the ordinary R.E. officer who has not specialized in survey, and to help him in the event of his being thrown

up suddenly from normal duties to gaze upon the heavenly bodies. The pages of the *Journal* are hardly the proper place to set forth all the administrative and other reasons for any particular course of action. On behalf of my Chief, I can reassure Major Norman that there were good grounds for entrusting this particular work to me rather than to an officer of the local or any other Fortress Company. At the same time, I doubt if Major Norman himself would spurn the assistance of a specialist Works officer if he were suddenly called upon to calculate—let us say—a reinforced-concrete T-beam, if he had not tackled such a problem since his courses at the S.M.E.

As to his suggestion that this was *the* job for a prismatic astrolabe, this might have been the case if the astronomical fixation of a few points had been the only task in contemplation, and if there had been no special transport or other conditions to take into account; further, few R.E. officers other than survey specialists are likely, in an emergency, to have such an instrument at their disposal. The claims of the astrolabe were, in point of fact, considered and rejected.

In the matter of the Tavistock theodolite it must be admitted that its rival, the Wild instrument, has got a good start in the markets of the world. I have very little experience with the Tavistock theodolite myself, and I have never used a Wild or a Zeiss, so I am unable to say from first-hand experience why the English instrument is better. If Major Norman will refer to the pages of the *Empire Survey Review*, he will find that another brother officer, Major Hotine, with experience of both instruments, definitely prefers the Tavistock, and has some very caustic things to say about the Wild. Furthermore, the new Tavistock, which has just come out, and in which more particularly the difficulty of the variability of the light gap has been overcome, will, I believe, prove even better. The Tavistock instrument I took to Aden was untested, and developed an unforeseen defect which could not be remedied on the spot. It may be mentioned that the design has since been amended by the makers to prevent a recurrence of this particular trouble.

British manufacturers are queer folk. They are certainly conservative and do not appear to mind whether people buy their wares or not, and should they want them they have to make considerable effort to get them, and often have to abide by the sweet will of the manufacturer for their delivery; but I believe their goods, when they are delivered, are "*the* goods," and as the manufacturers do indeed need encouragement in these days of financial stringency, it is perhaps unfortunate that the Survey of India have not so far seen their way to help them more in this direction.

Cost rates are, as Major Norman says, always interesting and often instructive, and I would go farther than Major Norman and say that their usefulness is not fully developed, until a comparison under exactly similar conditions can be arrived at. It seems useless,

though perhaps interesting, to compare transport rates by aeroplane in Aden with mules in Burma. A comparison of air rates and mule rates in Aden might be more useful, as might also be a comparison of air and mule rates in Burma. No doubt, however, in the latter case, the mule would win, but I very much doubt if it would in Aden.

Tape *versus* Hunter Short Base is again a question of availability. A tape is, at present, in any case the most likely to be available for the ordinary R.E. officer. Though I have no personal experience of the Hunter Short Base apparatus, I have seen it in the Science Museum and I have read with interest the accounts of it which have appeared from time to time. It is evidently a most useful and efficient piece of apparatus.

The method of recording the instant of observation by calling out "Up," is admittedly somewhat crude, but I doubt if it is any less accurate than the method of using the stop-watch. The latter has, of course, the advantage of making a second observer unnecessary, though, if the observer is there, why not make use of him and save trouble! Such crude methods must, I think, continue to be used until more refined apparatus is more generally available; I doubt if it ever will be available to the average R.E. officer.

It is refreshing to turn to Major Glennie's remarks, which are pleasant in tone and evidently helpful in intent. The ear and eye method of taking rhythmic signals is certainly open to improvement, but it means further apparatus. Many officers who use this method use it as an ear and ear method, getting their heads close to the chronometer and listening to the tick at the same time as they listen to the rhythmic signal in order to get the moment of coincidence. Some such method must be used in the absence of apparatus and what, I think, we need at the moment is convenient field apparatus, which would automatically record the rhythmic signal and the chronometer second on the same piece of paper. Such a method has, I believe, been worked upon by Mr. Bullard at Cambridge, but whether it is yet in a form convenient for field use I do not know. It would, I think, give the best solution. I have not had an opportunity of using the break circuit method which Major Glennie describes. Unfortunately, my chronometer had had the break circuit removed and replaced by a flashing mirror for use in gravity survey.

With regard to the question of using inert cells with the wireless apparatus; experiments are now being carried out with other forms of electrical energy, but the results will not be known for some time.

Yours faithfully,

R. E. FRYER, *Major, R.E.*

ROAD PROBLEM OF A FORCE OPERATING IN UNDEVELOPED COUNTRY.

To the Editor, *The Royal Engineers Journal.*

DEAR SIR,

In reply to Captain Singer's question* arising from my letter of March 27th last, I am of the opinion that, provided adequate traffic control were exercised, pneumatic-tyred traffic would consolidate a bitumen-bound soil rapidly and properly. This traffic control, which must be supplemented by reasonable driving, should aim at ensuring that the compressive effect of the wheels of the various vehicles is more or less equally distributed over all parts of the surface in turn. Naturally, the finish would not be comparable to that obtained by skilful rolling, and probably a slightly longer period would have to elapse after mixing before traffic could be allowed to effect the consolidation.

Yours faithfully,

E. G. WACE, *Brig.-General.*

* The question was, "Does General Wace consider that a 3-in. thickness of bitumen-bound soil will consolidate rapidly and properly under the pneumatic-tyred traffic to be expected on a forward road, or under a 2½-ton roller only." (*The R.E Journal*, June, 1933, p. 387.)

ROAD SURFACING BY THE MIX-IN-PLACE METHOD IN INDIA.

LOW-COST ROADS.

To the Editor, *The Royal Engineers Journal.*

DEAR SIR,

The article by Brigadier Haswell, C.I.E., in the June, 1933, number of *The Royal Engineers Journal*, describes a noteworthy advance in the economical treatment of roads under Indian conditions. The results of these trials should lead inevitably to the adoption of large-scale mechanical methods for road construction and improvement. It is only by the application of such methods, adapted where necessary to suit individual circumstances, that the enormous lengths of roads in the less settled areas of the world can be adequately treated within the means available.

These trials were carried out in a particularly fortunate locality in that ample and convenient supplies of gravel were available. The proximity of such an aggregate simplifies the method of treatment, particularly when the fines are screened out. This type of construction has for many years been practised in America (under the name of "Retread") and elsewhere throughout the world, and the

bituminous binders, including the requisite semi-stable emulsions, have for long been available.

It is a moot point, however, whether the slight decrease in cost obtained by the removal of the fines, as in this case, is not more than counter-balanced by the extra stability and durability which is gained by the laying of a denser finished product. In any event, circumstances in most of the less settled areas of the world preclude the screening out of the fines, and in such cases the use of specially designed bituminous binders, including stable emulsions, is essential. Such binders are now available almost everywhere, and they are capable of dealing not only with coarse aggregates, but also with the densely graded types, including earths and soils.

In previous issues of *The Royal Engineers Journal*, articles by Capt. Campbell, Capt. Noakes and myself have described instances of low-cost construction in various parts of the world. There is no doubt that considerable progress has been made in the technique and application of mix-in-place methods for incorporating binders with inferior aggregates.

As conditions differ so greatly in the larger unsettled countries and in the various districts within these countries, it would appear to be essential that trials of this nature should be widespread, covering varying types of aggregate and different grades of cut-back and emulsion. For instance, the H.R.M emulsion does not, in this case, seem suitable for aggregates containing an appreciable quantity of fines. Such trials embracing many different aggregates and binders form the indispensable preliminary to any comprehensive road scheme for modernizing transport facilities in backward countries.

Yours faithfully,

E. G. WACE, *Brig.-General.*

23rd October, 1933.

ECONOMICS.

To the Editor, *The R.E. Journal.*

DEAR SIR,

With regard to the letter from Colonel Hopkins in the September number of *The R.E. Journal*, attacking, at some length, the social credit theory of Major Douglas, I notice that you do not intend to open your columns to a discussion on economics; as a matter of fairness, however, you will, I hope, allow at least one opinion to be published on the other side.

I would summarize the main points of the social credit school of thought as follows:—

(1) The productive power of the world has increased enormously

in the last 100 years, and there is now no physical obstacle to the production of sufficient goods and services to give every individual a very high standard of living.

(2) The reason that production does not actually function in this way is that the would-be consumers have not sufficient purchasing power to buy all the goods and services which could be produced. Further, it can be demonstrated that, under our present financial system, the available purchasing power must of necessity be insufficient to buy all the goods which are produced.

(3) To set production going at "full blast," therefore, the creation of additional purchasing power (money or its equivalent) is required.

(4) Indiscriminate creation of money leads to unrestricted inflation (as happened in Germany after the war), which tends to make money worthless. It is, therefore, essential that the additional purchasing power created should be very carefully regulated, both as regards quantity and point of application, in such a manner as to increase consuming power in the way most beneficial to the country. A technique for this purpose has been thought out by exponents of social credit.

(5) The ideal aimed at is a general and progressive increase in the prosperity of all citizens of any country adopting the scheme. As compared with Socialist or Communist schemes, social credit has two great advantages :—

(*a*) It does not aim at "levelling down," or any appreciable reduction in the prosperity of anyone, but an increase all round, greatest where most needed.

(*b*) Instead of the regimentation required under Socialist schemes, there is to be as much encouragement as possible for individual initiative and enterprise ; a free as opposed to a servile state.

There are, of course, many questions arising which cannot be discussed here—the technique proposed, the reactions on international trade, foreign investment, and so on—but a study of the literature on the subject will, I think, show that satisfactory answers to all these questions can be found.

To turn now to Colonel Hopkins' letter. He will, I hope, forgive me for pointing out that, while he quotes page references to the book of Major Douglas which he has read, he nowhere gives its title ! His first paragraph, it is true, implies that there is only one such book on sale, but actually there are several, and the one I myself recently bought (*Social Credit*) is not the one from which he quotes.

It is not, however, necessary to go into Colonel Hopkins' letter in

detail, and I will only deal with the paragraphs which have a close bearing on the points I have mentioned above.

Regarding the increase in productive power in this age, Colonel Hopkins quotes Major Douglas' statement that productive power per man has increased forty-fold in the last 100 years, and says that, in his own opinion, the increase is only about 1½-fold (56 per cent. to be exact). I must admit that such a statement from a Sapper officer staggers me and I would only ask my brother officers to make their own estimates based on their own experience; one of my own latest experiences in this connection was a visit to the Peshawar District, where I saw roadmaking machines working with their small crews and eliminating whole gangs of coolies. As for the motor-car analogy, while it is true that one cannot compare "something" with "nothing," yet one can compare the number of man-hours now required to transport, say, 50 passengers or 50 tons by road with that required 100 years ago.

Regarding the question of creating money. Colonel Hopkins says that money is being confused with credit and that it is impossible to create money. If metallic coinage only were in question, these statements might be correct, but to the ordinary person "money" means purchasing power, and Colonel Hopkins himself appears to accept the definition of money as "any medium which no one will refuse to exchange for his goods." If I pay an hotel bill with a £20 cheque, and the hotel-keeper pays tradesmen's bills in the same manner, there is no movement of cash, only of bank credit, but we all get our "money's worth"; further, if my £20 is in the form of an overdraft, it has definitely, for the time being, been "created." When, therefore, Colonel Hopkins says that, "for 3,000 years or more the users of money have decided to accept only gold or silver as the medium [of exchange] . . . and it is a waste of time to reopen the question," I can only wonder where and how he lives.

To put the matter briefly, money viewed as purchasing power takes three forms:—

(*a*) Coin of intrinsic value—say 3 per cent.
(*b*) Paper money or notes of no intrinsic value—say 19 per cent.
(*c*) Bank credit—say 78 per cent.

The percentages I have given are taken from a book, *This Age of Plenty*, by C. M. Hattersley, M.A., LL.D., and are calculated for Great Britain in 1928. They agree, I think, roughly with one's own personal experience.

Of the above forms of money, the second can be created by a printing press and the third by book transactions; as already said, such creation must be done judiciously if the value of the money unit is not to be lowered, but all that is necessary in this respect is that the increase in the total quantity of money in circulation should

keep pace, as production expands, with the increase in the total quantity of goods and services, so that the proportion of money to goods remains approximately constant.

On the general question of money, Colonel Hopkins says, " Mill on the value of money and Adam Smith on the exchange value of commodities, have, I believe, left little to be said on these questions." I would submit, however, that it is just this blind reliance on economic pundits of the past that has led to the present absurd situation of " poverty in the midst of plenty," and that it is time we used common sense and first principles in economic matters.

After so much disagreement, let me say that I agree with Colonel Hopkins on one point ; I find the A + B theorem of Major Douglas somewhat unconvincing ; there are, however, other and simpler ways of proving that purchasing power must, under the existing system, of necessity prove inadequate. One such is given in Mr. Hattersley's book already quoted (Section 25).

I hope that this necessarily brief discussion of the subject may show that the social credit theory is worthy, at least, of very serious consideration by all who are interested in the welfare of the nation.

Yours truly,
R. HAMILTON, *Lt.-Col. R.E.*

[This correspondence must now cease.—EDITOR, *The R.E. Journal.*]

R.H.E.

To the Editor, *The Royal Engineers Journal.*

DEAR SIR,

The following are extracts from a " case " submitted for the opinion of the Law Officers in 1862 regarding W.D. rights on Woolwich Common. Among the various minutes is one apparently signed by the C.R.E. as follows :—

" Charles E. Ford,
Col. and Lt. Col[1], R.H.E.,
19th March, 1862."

In the previous and subsequent minutes to the one in question he is referred to as " the Commanding Royal Engineers."

Does the " H " stand for " Horse "—due to the home of the R.H.A. being at Woolwich, or has it another significance ?

Yours faithfully,
N. M. VIBART, *Major, R.E.*

2/11/33.